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Preliminary Compilation of Air Pollutant Emission Factors for Selected Air Toxic Compounds

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Research Triangle Park, NC

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16. ABSTRACT

This report presents emission factors for selected air toxic compounds, and it associates the emission factors to levels of source activity. The majority of the emission factors in this report was previously presented in Appendix H of the EPA report, Compiling Air Toxic Emission Inventories, EPA-450/4-86-010. Appendix H was updated to include emission factors for ethylene oxide and chlorobenzenes. The emission factors were compiled primarily in two series of EPA reports, Locating And Estimating Air Emissions From Sources Of (Substance) and Survey Of (Substance) Emission Sources.

The purpose of this report is to offer a technical service to air pollution control agencies in performing preliminary estimates of air toxics emissions. The emission factors are preliminary, and they are not intended to provide exact estimates of releases of air toxics from specific facilities.

17. KEY WORDS AND DOCUMENT ANALYSIS

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April 1987

PRELIMINARY COMPILATION OF AIR POLLUTANT EMISSION FACTORS FOR SELECTED AIR TOXIC COMPOUNDS

Air Management Technology Branch
Monitoring And Data Analysis Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park NC 27711

This report has been reviewed by the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, and approved for publication. Any mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use.

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MAILING LIST

The Environmental Protection Agency's Office of Air Quality Planning and Standards is providing technical support to assist State and local air pollution control agencies in developing and implementing air toxics programs. One way that OAQPS provides assistance to agencies and other interested individuals is by compiling and publishing emission data for various toxic air compounds. The purpose of these documents is to help agencies and others who are interested in locating potential emitters of toxic air compounds and in making preliminary estimates of toxic air emissions. These reports published by EPA are introductory documents only, and they are not intended to provide exact estimates of air toxics releases from specific facilities. EPA will update and expand these reports and publish new documents as toxic air emissions data are obtained. If you would like to receive notice of any new or updated air toxics emissions reports or if you have any additional air toxics emissions data, please complete the following mailing list form and mail it to the address on the form.

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Research Triangle Park, NC 27711

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SECTION 1. INTRODUCTION

The Environmental Protection Agency and State and local air pollution control agencies are in the process of developing air toxics programs. The development of an air toxics program may require the compilation of estimates of toxic air emissions from sources in a geographic area. One way to estimate air toxic emissions is by using emission factors. This report presents a preliminary compilation of emission factors for selected toxic air pollutants. The purpose of this report is to offer a technical service to air pollution control agencies in performing preliminary estimates of air toxics emissions.

An emission factor relates the quantity of a pollutant released to the atmosphere with a source activity (e.g. stripping, absorption, combustion, storage, handling,etc.). Emission factors are usually expressed by units of mass of pollutant emitted per unit of mass, volume, heat input, distance, or duration of a process that emits the pollutant (e.g. kg of pollutant emitted per Mg of product). Section 2 presents a listing of emission factors for selected toxic air pollutants and associates the emission factors to levels of source activity for pollutants. This is illustrated in Section 2 for carbon tetrachloride. Carbon tetrachloride is emitted when it is produced as a product, by-product, or intermediate during various processes and when it is used to formulate other compounds. If data are available, the emission factors in Section 2 are associated with unit operations for processes. For example, emission factors for carbon tetrachloride releases from perchloroethylene production result from neutralization, drying, distillation, and other operations; whereas only a process emission factor is listed for carbon tetrachloride emissions from pharmaceutical production facilities. For some toxic air pollutants in Section 2, the emission factors associated with processes or operations are further characterized by the presence or absence of emission reduction techniques or controls. For many of the controlled operations, the type of emission reduction control is identified. However, the emission reduction techniques in this report do not necessarily represent the best available control technology (BACT) or reasonably available control technology (RACT). Other information concerning the processes are included in the "Notes" of Section 2 to assist the users of this report. In addition, references are listed for each emission factor in this compilation.

The emission factors in this report are compiled from a review of the literature. Section 2 was previously presented in Appendix H of an EPA report entitled "Compiling Air Toxic Emission Inventories", EPA-450/4-010. Appendix H was updated to include emission factors for ethylene oxide and chlorobenzenes. The primary sources of information are those used to develop the EPA emission reports in the series "Survey of (Substance) Emission Sources" and in the series "Locating and Estimating Air Emissions from Sources of (Substance)". Because the available information on air toxics emissions is limited, emission factors are only provided for selected air toxics compounds and not for all identified

air toxics. The emission factors for the toxic compounds in this report are based on hypothetical facilities and do not consider the influence of various process design parameters such as temperature, reactant concentration, age of equipment, etc. If the emission factors were correlated to process design variables, they would provide more precise emission estimates than the factors in this report. Because insufficient data exist to determine the accuracy or validity of the emission factors in this compilation, no estimates can be made of the error that results from using these factors to calculate toxic air emissions from any given facility.

The emission factors in this report are intended to only be used for making preliminary estimates of toxic air emissions from various sources of air pollution. It should be understood that these factors will not likely provide exact estimates of emissions from any particular facility. Because these factors are obtained from data of varying degrees of accuracy and are made for hypothetical sources, emissions calculated for a facility using these emission factors may differ significantly from the actual emissions from the facility. In some cases, the differences in process design parameters possessed by the hypothetical and actual facilities could produce orders of magnitude differences between estimated and actual toxic air emissions. To estimate the most accurate releases from a facility, source specific data including specific source measurements and/or material balances should be used whenever possible. When source specific data are unavailable, more accurate emission estimates can be made by using information contained in the primary references listed in Section 2 in addition to the emission factors.

To illustrate the application of emission factors, an example is provided for acrylonitrile. If an agency decides to estimate acrylonitrile emissions in an area, it could make preliminary estimates of emissions by using emission factors in Section 2 and data on material usage records, permit applications, or inspector records of facilities producing or using acrylonitrile. However, it must be emphasized that these estimates can vary greatly from actual emissions because the factors are based on releases from hypothetical plants with hypothetical emission controls. To develop a more accurate emissions estimate, the primary reference listed in Section 2, "Locating and Estimating Air Emissions from Sources of Acrylonitrile", should be reviewed. A comparision of the process parameters of the hypothetical plant contained in the primary references and of those of the actual facility allows the agency to determine the sources of error associated with using the emission factors and to produce more realistic emission estimates. If source specific data are unavailable, then the agency should view the calculated acrylonitrile emissions as only a preliminary estimate.

This preliminary compilation of air toxics emission factors will be updated and expanded as new information is obtained on process descriptions, operating practices, control measures, and emissions data. Comments on the contents or usefulness of this document is welcomed, as is any emission

information that would allow EPA to update and expand the preliminary list of toxic air emission factors. All comments should be sent to:

Chief, Noncriteria Emissions Section
MD-14
Air Management Technology Branch
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711.

SECTION 2. EMISSION FACTORS FOR TOXIC AIR POLLUTANTS

Pollutant	Process	Emission Factor	Notes	Reference
Acetaldehyde	Wood combustion - residential			
	Woodstove	0.22 lb/ton wood burned		2
	Woodstove	0.24 lb/ton wood burned		3
	Fireplace	1.4 lb/ton wood burned		2
	Wood combustion - commercial, industrial	0.24 lb/ton wood burned		3
Acrylonitrile	Production plant			
	Absorber vent (normal)	0.10 g/kg produced	Uncontrolled	15
		0.002 g/kg produced	Controlled; thermal incinerator 98% assumed emission reduction	15
	Absorber vent (startup)	0.187 g/kg produced	Uncontrolled	15
	Column vents	5.00 g/kg produced	Uncontrolled	15
		0.10 g/kg produced	Controlled; flare (vent H) 98% assumed emission reduction	15
	Storage vents			
	Crude acrylonitrile	0.048 g/kg produced	Uncontrolled	15
		0.00048 g/kg produced	Controlled; water scrubber 99% assumed emission reduction	15
	Acrylonitrile run tanks	0.128 g/kg produced	Uncontrolled	15
		0.00128 g/kg produced	Controlled; water scrubber 99% assumed emission reduction	15
	Acrylonitrile storage	0.531 g/kg produced	Uncontrolled	15
		0.00531 g/kg produced	Controlled; water scrubber 99% assumed emission reduction	15
	Handling (tank car loading)	0.167 g/kg produced	Uncontrolled	15
		0.0017 g/kg produced	Controlled; water scrubber 99% assumed emission reduction	15
	Handling (barge loading)	0.150 g/kg produced	Uncontrolled	15
		0.0011 g/kg produced	Controlled; water scrubber 99% assumed emission reduction	15
	Fugitive	0.806 g/kg produced	Uncontrolled	15
		0.238 g/kg produced	Controlled; detection and correction of major leaks. 71% assumed emission reduction	15

Pollutant	Process	Emission Factor	Notes	Reference
Arsenic	Mining	0.2 lb/ton of arsenic in ore		8
	Cast iron	0.01 to 0.02 lb/ton of metal charged		8
	Nonferrous alloys	1 lb/ton of arsenic processed		8
	Pesticide production for agricultural uses	20 lb/ton of arsenic processed		8
	Glass production	0.2 lb/ton of glass produced		8
	Wood preservatives	Negligible		8
	Others (paint pigments, pyrotechnics, pharmaceutical, semiconductors, etc.)	3 lb/ton of arsenic processed		8
	Cotton ginning processing	4 lbs/1000 bales of cotton ginned		8
	Foreign residual oil			
	No. 6 fuel oil, Mexico	0.0008 lb/1000 gallons	0.1 content, ppm	8
	No. 6 fuel oil, Virgin Islands	0.0008 to 0.002 lb/1000 gallons	0.1 to 0.2 content, ppm	8
	No. 6 fuel oil, Trinidad	0.0007 lb/1000 gallons	0.095 content, ppm	8
	No. 6 fuel oil, Curacao, N.A.	0.001 to 0.002 lb/1000 gallons	0.16 to 0.2 content, ppm	8
	Average for foreign residual oil	0.001 lb/1000 gallons	0.14 content, ppm	8
	Foreign crude oils			
	Neutral zone crude No. 24	0.0006 lb/1000 gallons	0.079 content, ppm	8
	Boscan crude oil, Morovia	0.002 lb/1000 gallons	0.34 content, ppm	8
	Jabo crude oil, Venezuela	0.0004 lb/1000 gallons	0.053 content, ppm	8
	Kuwait crude oil, Kuwait	0.00007 lb/1000 gallons	0.01 content, ppm	8
	Boscan crude oil, Venezuela	0.02 lb/1000 gallons	0.31 content, ppm	8
	Lagunillas crude oil, Venezuela	0.0009 lb/1000 gallons	0.12 content, ppm	8
	UMM Farvo, Libya	0.0001 lb/1000 gallons	0.02 content, ppm	8
	Average for foreign crude oils	0.0009 lb/1000 gallons	0.13 content, ppm	8
	U.S. crude oils			
	St. Tedesa, Illinois	0.004 lb/1000 gallons	0.61 content, ppm	8
	Maysville, W. Oklahoma	0.0002 lb/1000 gallons	0.031 content, ppm	8
	Hall-Gurney, Kansas	0.0003 lb/1000 gallons	0.047 content, ppm	8
	East Texas, Texas	0.00005 lb/1000 gallons	0.007 content, ppm	8
	Grass Creek, Walker Dome, Wyoming	0.0003 lb/1000 gallons	0.04 content, ppm	8
	Average for U.S. crude oils	0.001 lb/1000 gallons	0.15 content, ppm	8
	Cotton ginning waste burned	17 lb/1000 bales of cotton ginned		8
	Sewage and sludge	0.02 lb/ton of sewage and sludge		8

Pollutant	Process	Emission Factor	Notes	Reference
Arsenic (continued)	Coal combustion-industrial			
		0.04 lb/ton	Uncontrolled	2
		0.0004 lb/ton	ESP	2
	Sewage Sludge Incinerators	0.2-3.9 lb/1000 ton		2
		0.07-7.2 lb/ton		3
	Combustion of bituminous coal-residential	0.4 lb/ton		2
	Waste oil	0.000075-0.0069 lb/1000 gallons		3
	Primary lead smelting	0.88 lb/ton of lead produced		6
	Utility boilers			7
	Bituminous coal			
	Pulverized dry bottom	15.3 pg/J heat input	ESP	7
		5.3 pg/J heat input	Scrubber	7
		133 pg/J heat input	Uncontolled	7
	Pulverized wet bottom	12.4 pg/J heat input	ESP	7
	Cyclone	3.0 pg/J heat input	ESP	7
	Stoker	206 pg/J heat input	Multicyclones	7
	Anthracite coal			
	Pulverized	15.3 pg/J heat input	ESP	7
	Stoker	206 pg/J heat input	Multicyclones	7
	Lignite coal			
	Pulverized dry bottom	6.8 pg/J heat input	ESP	
	Pulverized wet bottom	5.5 pg/J heat input	ESP	7
	Cyclone	6.7 pg/J heat input	ESP	7
		120 pg/J heat input	Multicyclones	7
	Stoker	206 pg/J heat input	Multicyclones	7
	Residual oil			
	Tangential	9.5 pg/J heat input	ESP	7
		47.3 pg/J heat input	Uncontrolled	7
	Wall	9.5 pg/J heat input	ESP	7
		47.3 pg/J heat input	Uncontrolled	7

Pollutant	Process	Emission Factor	Notes	Reference
Arsenic (continued)	Industrial boilers			
	Pulverized	280 pg/J heat input	Multicyclones	7
		92.0 pg/J heat input	Scrubber	7
	Stoker	206 pg/J heat input	Multicyclones	7
		482 pg/J heat input	Uncontrolled	7
	Tangential	9.4 pg/J heat input	Scrubber	7
		47.3 pg/J heat input	Uncontrolled	7
	Wall	9.4 pg/J heat input	Scrubber	7
		47.3 pg/J heat input	Uncontrolled	7
	Commercial boilers			
	Coal	482 pg/J heat input	Stoker	7
	Residual	47.3 pg/J heat input	Tangential	7
	Oil	47.3 pg/J heat input	Wall	7
	Distillate	47.3 pg/J heat input	Tangential	7
	Oil	47.3 pg/J heat input	Wall	7
	Residential			
	Bituminous coal	717 pg/J heat input	All	7
	Anthracite coal	166 pg/J heat input	All	7
	Lignite coal	430 pg/J heat input	All	7
	Distillate coal	1.5 pg/J heat input	All	7
Asbestos	Brake Wear	2.6 ug/km/vehicle		6
	Mining and milling			
	Mining, total	9 to 10 lb/ton mined		8
	Mining	3 lb/ton mined		8
	Loading	2 lb/ton mined		8
	Hauling	2 lb/ton mined		8
	Unloading	2 lb/ton mined		8
	Mining, total, 50% control	5 lb/ton mined		8
	Milling	100 lb/ton milled		8
	Milling, 50% control	80 lb/ton milled		8

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Asbestos (continued)	Milling	20 lb/ton milled	80% Controlled	8
	Processing			
	Friction material	6 lb/ton asbestos processed	Controlled	8
	Asbestos cement products	1 lb/ton asbestos processed	Controlled	8
	Textiles	40 lb/ton asbestos processed	Uncontrolled	8
		2 lb/ton asbestos processed	Controlled	8
	Asbestos paper	4 lb/ton asbestos processed	Uncontrolled	8
		1 lb/ton asbestos processed	Controlled	8
	Floor tile	4 lb/ton asbestos processed	Uncontrolled	8
		1 lb/ton asbestos processed	Controlled	8
Benzene	Petroleum refinery			
	Crude storage/handling	0.0047 lb/1000 gal crude		7
	Refinery operations	0.01 lb/1000 gal crude		7
	Benzene production	0.5 lb/1000 gal benzene produced		7
	Gasoline marketing	0.184 lb/1000 gal gasoline		7
Benzo(a)pyrene	Open wood fires	0.00025 - 0.0014 lb/ton wood burned		3
	Utility boilers			
	Pulverized dry bottom	0.03 pg/J heat input	ESP or multicyclone, bituminous coal	7
	Pulverized wet bottom	0.08 pg/J heat input	ESP or multicyclone, bituminous coal	7
	Cyclone	0.08 pg/J heat input	ESP, bituminous coal	7
	Stoker	0.10 pg/J heat input	Multicyclones, bituminous or anthracite coal	7
	Pulverized dry bottom	0.07 pg/J heat input	ESP, lignite coal	7
	Pulverized wet bottom	0.09 pg/J heat input	Uncontrolled, lignite coal	7
	Cyclone	0.09 pg/J heat input	ESP, lignite coal	7
	Stoker	0.09 pg/J heat input	Multicyclone, lignite coal	7
	Tangential	0.002 pg/J heat input	Residual oil, scrubber	7

Pollutant	Process	Emission Factor	Notes	Reference
Benzo(a)pyrene (continued)	Industrial boilers			
	Pulverized	0.03 pg/J heat input	Multicyclone, coal fired	7
	Stoker	0.03 pg/J heat input	Multicyclone, coal fired	7
	Stoker	0.06 pg/J heat input	Uncontrolled, coal fired	7
	Tangential	0.13 pg/J heat input	Uncontrolled, oil fired	7
	Wall	0.2 pg/J heat input	Uncontrolled, oil fired	7
	Commercial boilers			
	Stoker	4.7 pg/J heat input	Uncontrolled, coal fired	7
	Tangential and wall	0.4 pg/J heat input	Uncontrolled, residual oil or distillate oil	7
	Residual boilers			
	All	108 pg/J heat input	Bituminous coal	7
	All	106 pg/J heat input	Anthracite coal	7
	All	108 pg/J heat input	Lignite coal	7
	All	0.1 pg/J heat input	Distillate oil	7
Beryllium	Mining	0.2 lb/ton Be mined		8
	Cement plants			
	Dry process	0.00003 lb/1000 tons produced		8
	Wet process			
	Kiln	0.002 lb/1000 tons produced		8
	Clinker cooler	0.0008 lb/1000 tons produced	ESP	8
	Clinker cooler	0.0009 lb/1000 tons produced	Baghouse	8
	Beryllium alloys (stamped and drawn)	0.1 lb/ton Be processed		8
	Beryllium alloys (molding)	0.01 lb/ton alloy produced	Uncontrolled	8
		0.0004 lb/ton alloy produced	Baghouse	8
	Ceramics	1 lb/ton Be processed	Controlled	8
	Beryllium metal fabrication	0.1 lb/ton of Be processed	Controlled	8
	Oil combustion (residual)	0.0008 lb/1000 gallons burned		8
	Sewage sludge incineration, multiple hearth	0.0009-0.003 lb/1000 ton waste	Wet scrubber	8

Pollutant	Process	Emission Factor	Notes	Reference
Beryllium (continued)	Sewage sludge incineration, fluidized bed	0.0001-0.002 lb/1000 ton waste	Wet scrubber	8
	Municipal refuse incinerator	0.03 lb/1000 ton waste	Uncontrolled	8
		0.03 lb/1000 ton waste	ESP	8
	Gray iron production	0.00044 lb/ton gray iron produced		3
	Waste oil combustion	0.0075 lb/1000 gal		3
	Coal combustion, industrial	0.005 lb/ton	Uncontrolled	2
		0.0001 lb/ton	ESP	2
	Utility boilers			
	Bituminous coal			
	Pulverized dry bottom	2.1 pg/J heat input	ESP	7
		6.9 pg/J heat input	Multicyclone	7
		0.3 pg/J heat input	Scrubber	7
		23.7 pg/J heat input	Uncontrolled	7
	Pulverized wet bottom	1.7 pg/J heat input	ESP	7
		5.6 pg/J heat input	Multicyclone	7
		0.2 pg/J heat input	Scrubber	7
		18.9 pg/J heat input	Uncontrolled	7
	Cyclone	0.6 pg/J heat input	ESP	7
		1.2 pg/J heat input	Multicyclone	7
		0.7 pg/J heat input	Scrubber	7
		4.0 pg/J heat input	Uncontrolled	7
	Stoker	5.6 pg/J heat input	Multicyclone	7
		18.1 pg/J heat input	Uncontrolled	7
	Anthracite coal			
	Pulverized	2.1 pg/J heat input	ESP	7
	Stoker	5.6 pg/J heat input	Multicyclone	7
	Lignite coal			
	Pulverized dry bottom	0.6 pg/J heat input	ESP	7
		0.3 pg/J heat input	Scrubber	7
		64.5 pg/J heat input	Uncontrolled	7
	Pulverized wet bottom	0.5 pg/J heat input	ESP	7

Pollutant	Process	Emission Factor	Notes	Reference
Beryllium (continued)	Cyclone	0.3 pg/J heat input	ESP	7
		3.0 pg/J heat input	Multicyclone	7
		0.2 pg/J heat input	Scrubber	7
		55.9 pg/J heat input	Uncontrolled	7
	Residual oil			
	Tangential, wall	0.6 pg/J heat input	ESP	7
		0.002 pg/J heat input	Scrubber	7
		2.3 pg/J heat input	Uncontrolled	7
	Industrial boilers			
	Coal-fired			
	Pulverized	1.9 pg/J heat input	ESP	7
		6.5 pg/J heat input	Multicyclone	7
		1.0 pg/J heat input	Scrubber	7
		21.5 pg/J heat input	Uncontrolled	7
	Stoker	5.6 pg/J heat input	Multicyclone	7
		18.1 pg/J heat input	Uncontrolled	7
	Oil-fired			
	Tangential, wall	0.3 pg/J heat input	Scrubber	7
		1.9 pg/J heat input	Uncontrolled	7
	Commercial boilers			
	Coal-fired			
	Pulverized	9.1 pg/J heat input		7
	Stoker	18.1 pg/J heat input		7
	Residual or distillate oil-fired			
	Tangential, wall	0.1 pg/J heat input		7
	Residual boilers			
	All	7.2 pg/J heat input	Bituminous coal	7
	All	6.6 pg/J heat input	Anthracite coal	7
	All	1.7 pg/J heat input	Lignite coal	7
	All	1.9 pg/J heat input	Distillate oil	7

Pollutant	Process	Emission Factor	Notes	Reference
Butyl carbitol	Integrated circuit board manufacture - screening	0.08 ton/100,000 sq ft product		4
Butyl cellosolve	Integrated circuit board manufacture - developer	0.78 ton/100,000 sq ft product		4
Cadmium	Mining of zinc bearing ore	0.2 lb/ton Cd mined	Uncontrolled	8
	Zinc smelting	300 lb/ton Cd charged	Not for electrolytic process	8
	Copper smelting	1300 lb/ton Cd charged		8
	Lead smelting	1300 lb/ton Cd charged		8
	Cadmium refining	25 lb/ton Cd produced		8
	Secondary lead - reverberatory furnace	0.1-0.4 lb/ton Pb	Controlled	8
	Steel scrap	0.003 lb/ton steel produced	Uncontrolled	8
	Secondary lead smelter	0.00044 lb/ton lead		6
	Cement			
	Dry process	0.0004 lb/ton of feed		6
	Wet process	0.0002 lb/ton of feed		6
	Sewage sludge incineration	0.34 lb/ton waste		6
	Municipal waste incineration	0.009 lb/ton waste		2
	Waste oil combustion	0.003-0.15 lb/1000 gal		3
	Vehicle tire wear	1.07 E-08 lb/mile traveled		6
	Industrial boilers			
	Pulverized	2.7 pg/J heat input	Multicyclone, coal-fired	7
		0.4 pg/J heat input	Scrubber, coal-fired	7
		8.9 pg/J heat input	Uncontrolled, coal-fired	7
	Stoker	5.5 pg/J heat input	Multicyclone, coal-fired	7
		17.9 pg/J heat input	Uncontrolled, coal-fired	7

Pollutant	Process	Emission Factor	Notes	Reference
Cadmium (continued)	Tangential, wall	21.0 pg/J heat input	Scrubber, oil-fired	7
		71.3 pg/J heat input	Uncontrolled, oil-fired	7
	Commercial boilers			
	Stoker	12.9 pg/J heat input	Uncontrolled, coal-fired	7
	Tangential, wall	71.8 pg/J heat input	Uncontrolled, oil-fired	7
	Residual boilers			
	All	17.9 pg/J heat input	Bituminous coal	7
	All	6.6 pg/J heat input	Anthracite coal	7
	All	1.7 pg/J heat input	Lignite coal	7
	All	11.0 pg/J heat input	Distillate oil	7
	Utility boilers			
	Pulverized dry bottom	0.8 pg/J heat input	Multicyclone, bituminous coal	7
		1.7 pg/J heat input	Uncontrolled, bituminous coal	7
	Pulverized wet bottom	8.9 pg/J heat input	ESP, bituminous coal	7
		0.6 pg/J heat input	Multicyclone, bituminous coal	7
	Cyclone	0.3 pg/J heat input	Multicyclone, bituminous coal	7
	Stoker	5.5 pg/J heat input	Uncontrolled, bituminous coal	7
		0.8 pg/J heat input	Multicyclone, anthracite coal	7
	Pulverized dry bottom	5.5 pg/J heat input	ESP, lignite coal	7
		0.3 pg/J heat input	Multicyclone, lignite coal	7
		15.1 pg/J heat input	Scrubber, lignite coal	7
	Pulverized wet bottom	0.3 pg/J heat input	Multicyclone, lignite coal	7
	Cyclone	0.7 pg/J heat input	Multicyclone, lignite coal	7
		9.8 pg/J heat input	Scrubber, lignite coal	7
	Stoker	5.5 pg/J heat input	Uncontrolled, lignite coal	7
	Tangential, wall	14.4 pg/J heat input	Scrubber, residual oil	7
		71.8 pg/J heat input	Uncontrolled, residual oil	7
Carbon tetrachloride	Carbon tetrachloride production -			
	Hydrocarbon chlorinolysis:			
	Distillation column	0.008 kg/Mg produced	Uncontrolled	16

Pollutant	Process	Emission Factor	Notes	Reference
Carbon tetrachloride (continued)	Storage	0.098-0.58 kg/Mg produced 0.013-0.087 kg/Mg produced	Uncontrolled Refrigerated condenser	16 16
	Tank truck/car loading	0.24 kg/Mg produced 0.036 kg/Mg produced	Uncontrolled Refrigerated condenser	16 16
	Waste handling	0.0046 kg/Mg produced 0.000046 kg/Mg produced	Uncontrolled Vapor balance and refrigerated condenser	16 16
	Waste caustic	0.0029 kg/Mg produced 0.00012 kg/Mg produced	Uncontrolled Steam stripper	16 16
	Process fugitive	1.5 kg/hr produced 0.41-0.78 kg/hr produced	Uncontrolled Monthly inspection/maintenance, double mechanical seals	16 16
	Carbon tetrachloride production - Methane chlorination process:			
	Recycled methane inert gas purge vent	0.042 kg/Mg produced	Uncontrolled	16
	Distillation area emergency inert gas vent	0.052 kg/Mg produced	Uncontrolled	16
	Storage	0.057-0.64 kg/Mg produced 0.0046-0.096 kg/Mg produced	Uncontrolled Refrigerated condenser	16 16
	Handling	0.24 kg/Mg produced 0.036 kg/Mg produced	Uncontrolled Refrigerated condenser	16 16
	Process fugitives	2.56 kg/hr 0.74-1.6 kg/hr	Uncontrolled Monthly inspection/maintenance, double mechanical seals	16 16
	Carbon tetrachloride production - Carbon disulfide chlorination process:			
	Chlorinator	116 kg/Mg produced 5.8 kg/Mg produced	Uncontrolled Refrigerated condenser	16 16
	Storage	0.76 kg/Mg produced 0.11 kg/Mg produced	Uncontrolled Refrigerated condenser	16 16

Pollutant	Process	Emission Factor	Notes	Reference
Carbon tetrachloride (continued)	Handling	0.24 kg/Mg produced	Uncontrolled	16
		0.036 kg/Mg produced	Refrigerated condenser	16
	Process fugitives	0.60 kg/hr	Uncontrolled	16
		0.14-0.32 kg/hr	Inspection/maintenance, double mechanical seals	16
	Carbon tetrachloride production -			
	Methanol hydrochlorination/methyl chloride chlorination process:			
	Storage	0.040-1.39 kg/Mg	Uncontrolled	16
		0.0012-0.21 kg/Mg	Refrigerated condenser	16
	Handling	0.52 kg/Mg	Uncontrolled	16
		0.078 kg/Mg	Refrigerated condenser	16
	Process fugitives	0.48 kg/Mg	Uncontrolled	16
		0.091-0.28 kg/Mg	Controlled	16
	Fluorocarbon 11 and 12 production:			
	Reactor venting	0.042 kg/Mg produced	Uncontrolled	16
	Distillation column	0.023 kg/Mg produced	Refrigerated condenser and scrubber	16
	Storage	0.19-0.74 kg/Mg produced	Uncontrolled	16
		0.029-0.11 kg/Mg produced	Refrigerated condenser	16
	Pharmaceutical production	110 kg/Mg carbon tetrachloride used	Controlled	16
	Ethylene dichloride production -			
	Balanced process:			
	Oxychlorination vent			
	Air process	0.29-1.2 kg/Mg produced	Uncontrolled	16
		0.0058 - 0.024 kg/Mg produced	Thermal oxidizer	16
	Oxygen process	0.044-0.18 kg/Mg produced	Uncontrolled	16
		0.00088 - 0.0036 kg/Mg produced	Thermal oxidizer	16
	Column vents	0.14 kg/Mg produced	Uncontrolled	16
		0.0028 kg/Mg produced	Thermal oxidizer	16
	Liquid waste storage	0.0051 kg/Mg produced	Uncontrolled	16
		0.00077 kg/Mg produced	Refrigerated condenser	16

Pollutant	Process	Emission Factor	Notes	Reference
Carbon tetrachloride (continued)	Perchloroethylene production -			
	Ethylene dichloride chlorination			
	Neutralization	0.016 kg/Mg produced	Uncontrolled	16
	Drying column	0.063 kg/Mg produced	Uncontrolled	16
		0.005 kg/Mg produced	Condenser	16
	Distillation column	0.027 kg/Mg produced	Uncontrolled	16
	Light ends/heavy ends air tank	0.039 kg/Mg produced	Uncontrolled	16
		0.022 kg/Mg produced	Condenser	16
	Storage - light ends	0.11 kg/Mg produced	Uncontrolled	16
		0.0012 kg/Mg produced	Condenser	16
	Process fugitive	2.8 kg/hr	Uncontrolled	16
Chlorobenzenes	Monochlorobenzene production	3.20 kg/Mg produced		27
	o-Dichlorobenzene production	3.55 kg/Mg produced		27
	p-Dichlorobenzene production	7.24 kg/Mg produced		27
	Dye synthesis	0.50 kg o-Dichlorobenzene /Mg dye synthesized		27
	Pharmaceutical production	140 g o-Dichlorobenzene/Mg used		27
Chloroform	Waste oil combustion	0.03-0.33 lb/1000 gal		3
	Chloroform production -			
	Methanol hydrochlorination/methyl chloride chlorination process:			
	Chloroform distillation vent	0.022 kg/Mg produced	Uncontrolled	17
	Storage	0.061-0.97 kg/Mg produced	Uncontrolled	17
	Handling	0.33 kg/Mg produced	Uncontrolled	17
		0.033 kg/Mg produced	Condenser	17
	Process fugitive	1.4 kg/hr	Uncontrolled	17
		0.32 kg/hr	Controlled	17

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Chloroform (continued)	Methane chlorination process:			
	Recycled methane inert gas purge vent	0.013 kg/Mg produced	Uncontrolled	17
	Distillation area emergency inert gas vent	0.032 kg/Mg produced	Uncontrolled	17
	Storage	0.088-0.83 kg/Mg produced	Uncontrolled	17
		0.073 kg/Mg produced	Controlled	17
	Secondary	0.21 kg/Mg produced	Uncontrolled	17
	Handling	0.33 kg/Mg produced	Uncontrolled	17
		0.035 kg/Mg produced	Condenser	17
	Process fugitive	3.1 kg/hr	Uncontrolled	17
		0.74 kg/hr	Controlled	17
	Fluorocarbon 22 production -			
	Storage	0.59-2.5 kg/Mg produced	Uncontrolled	17
		0.03-0.125 kg/Mg produced	Refrigerated condenser	17
	Fugitive	0.023 kg/hr	Controlled	17
	Ethylene dichloride production by balanced process -			
	Oxychlorination vent:			
	Air process	0.033-0.85 kg/Mg produced	Uncontrolled	17
		6.6 E-04 - 1.3 E-07 kg/Mg produced	Thermal oxidizer	17
	Oxygen process	0.005-0.12 kg/Mg produced	Uncontrolled	17
		0.0001 - 0.0024 kg/Mg	Thermal oxidizer	17
	Column vents	1.0 kg/Mg produced	Uncontrolled	17
		0.02 kg/Mg produced	Thermal oxidizer	17
	Liquid waste storage	0.003 kg/Mg produced	Uncontrolled	17
		0.00045 kg/Mg produced	Refrigerated condenser	17
	Pulp/paper mills -			
	Integrated mills:			
	Dissolving kraft pulp	0.12 kg/Mg produced	During wastewater treatment	10
		0.013 kg/Mg produced	After wastewater treatment	10

Pollutant	Process	Emission Factor	Notes	Reference
Chloroform (continued)	Market bleached kraft pulp	0.22 kg/Mg produced 0.0019 kg/Mg produced	During wastewater treatment After wastewater treatment	10 10
	Bleached kraft paperboard, coarse paper, tissue paper	0.22 kg/Mg produced 0.00090 kg/Mg produced	During wastewater treatment After wastewater treatment	10 10
	Soda and kraft fine bleached papers	0.13 kg/Mg produced 0.0059 kg/Mg produced	During wastewater treatment After wastewater treatment	10 10
	Dissolving sulfite pulp	0.069 kg/Mg produced 0.0033 kg/Mg produced	During wastewater treatment After wastewater treatment	10 10
	Sulfite papergrade pulp	0.38 kg/Mg produced 0.074 kg/Mg produced	During wastewater treatment After wastewater treatment	10 10
	Pulp/paper mills:			
	Secondary fiber mills			
	Deink - fine paper	0.36 kg/Mg produced 0.013 kg/Mg produced	During wastewater treatment After wastewater treatment	10 10
	Deink - tissue paper	0.16 kg/Mg produced 0.0067 kg/Mg produced	During wastewater treatment After wastewater treatment	10 10
	Pharmaceutical manufacture	160 kg/Mg used	Controlled	11
	Cooling tower	0.41 kg/10 E+09 l	Uncontrolled	11
	Drinking water	0.041 kg/1,000,000 l treated	Uncontrolled	11
	Municipal wastewater	0.014 kg/1,000,000 l discharged	Uncontrolled	11
	Sludge	580 kg/1,000,000 Mg treated by super chlorination	Uncontrolled	11
Chromium	Chromite ore refining		Factor reported as total elemental chromium.	
	Chromite ore dryer	0.009 lb/ton of chromite ore processed 0.002 lb/ton of chromite ore processed	Bag collector Wet scrubber; 99.9% control efficiency	9 9
	Hording mill and cyclone	0.005 lb/ton of chromite ore processed	Fabric filter	9

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	Refined ore storage	0.09 lb/ton of chromite ore processed	Uncontrolled	9
		0.00009 lb/ton of chromite ore processed	Dust collector (filter cartridge)	9
	Processing of raw materials at ferrochrome plants -		Factors expressed as total elemental chromium.	
	Receipt and storage of chrome ore in stock pile	0.68 lb/ton of chrome ore processed	15% of sources used to develop this factor were controlled.	9
	Drying, crushing, and sizing of chrome ore	0.68 lb/ton of chrome ore processed	75% of sources used to develop this factor were controlled.	9
	Weighing and feeding chrome ore to electric arc furnace	0.61 lb/ton of chrome ore processed	20% of sources used to develop this factor were controlled.	9
	Electric arc furnaces used to produce ferrochromes -			
	Ferrochrome - silicon	3.3-12 lb/ton of product 0.45-1.6 lb/MW-hr	Uncontrolled; assumes chromium is 0.4 to 1.4% of total particulate emissions by weight.	9
	High-carbon ferrochrome and charge chrome	47 lb/ton of product 8.7 lb/MW-hr	Uncontrolled; assumes chromium is 14% of total particulate emissions by weight.	9
	Chrome ore/lime melt	1.6 lb/ton of product 1.4 lb/MW-hr	Uncontrolled; assumes chromium is 15% of total particulate emissions by weight.	9
	Ferrochrome - silicon	0.0076 lb/MW-hr	Controlled; assumes chromium is 0.4% of total controlled particulate emissions by weight.	
	Ferrochrome - silicon	0.0018 lb/MW-hr	Controlled; assumes chromium is 0.4% of total controlled particulate emissions by weight.	
	Ferrochrome - silicon	0.0017 lb/MW-hr	Controlled; assumes chromium is 0.4% of total controlled particulate emissions by weight.	
	Ferrochrome - silicon	0.00004 lb/MW-hr	Controlled; assumes chromium is 0.4% of total controlled particulate emissions by weight.	
	High-carbon ferrochrome and charge chrome	0.15 lb/MW-hr	Controlled; assumes chromium is 14% of total particulate emissions by weight.	

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	High-carbon ferrochrome	0.0049 lb/MW-hr	Controlled; assumes chromium is 14% of total particulate emissions by weight.	
	High-carbon ferrochrome	0.091 lb/MW-hr	Controlled; assumes chromium is 14% of total particulate emissions by weight.	
	High-carbon ferrochrome	0.38 lb/ton of product 0.090 lb/MW-hr	Controlled; assumes chromium is 14% of total particulate emissions by weight.	
	High-carbon ferrochrome	0.045 lb/MW-hr	Controlled; assumes chromium is 14% of total particulate emissions by weight.	
	Finishing operations and product handling at ferrochrome plants -		Factors expressed as total elemental chromium.	
	Treatment of molten alloy with chlorine or other gas in ladle:		25% of sources used to determine factors were controlled.	
	Ferrochrome - silicon	3.4 lb/ton of product		9
	High-carbon ferrochrome	6.6 lb/ton of product		9
	Casting of ferrochrome product:		42% of sources used to determine factors were controlled.	
	Ferrochrome - silicon	0.072 lb/ton of product		9
	High-carbon ferrochrome	0.14 lb/ton of product		9
	Crushing/Grinding of product:		93% of sources used to determine factors were controlled.	
	Ferrochrome - silicon	0.22 lb/ton of product		9
	High-carbon ferrochrome	0.42 lb/ton of product		9
	Refractory industry -		Factors expressed as total elemental chromium.	
	Total pressing process	150 lb/ton of refractory produced, 54 lb/ton of refractory produced	Uncontrolled Controlled; 64% control efficiency	9 9
	Ore crushing, sizing, drying	150 lb/ton of refractory produced, 54 lb/ton of refractory produced	Uncontrolled Controlled; 64% control efficiency	9 9
	Brick firing kilns	0.2 lb/ton of refractory produced	Uncontrolled	9
	Total fusion casting process	225 lb/ton of refractory produced, 52 lb/ton of refractory produced	Uncontrolled Controlled; 77% control efficiency	9 9
	Ore crushing, sizing, drying	150 lb/ton of refractory produced, 34 lb/ton of refractory produced	Uncontrolled Controlled; 77% control efficiency	9 9

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	Fusion melting, casting, breakout, and finishing	75 lb/ton of refractory produced, 18 lb/ton of refractory produced	Uncontrolled Controlled; 77% control efficiency	9 9
	Refractory industry -		Factors reported as total elemental chromium	
	Chrome-magnesite brick production:			
	Chrome Ore Preparation			
	Ore storage, grinding, and sizing (chrome ore)	0.02-0.10 lb/ton of raw materials processed	Fabric filter; 99.9% control efficiency	9
	Dryer (chrome ore)	0.0035-0.0041 lb/ton of raw materials processed	Fabric filter; 99.9% control efficiency	9
	Storage in raw materials silo (chrome ore and magnesite)	0.0045-0.0065 lb/ton of raw materials processed	Fabric filter; 99.9% control efficiency	9
	Processing and Firing			
	Mixer (chrome ore and magnesite)	0.0011-0.0043 lb/ton of raw materials processed	Fabric filter; 99.9% control efficiency	9
	Brick dryer (chrome ore and magnesite)	0.00074 lb/ton of raw materials processed	Scrubber; 90% control efficiency	9
	Brick kiln (chrome ore and magnesite)	0.00099 lb/ton of raw materials processed	Scrubber; 90% control efficiency	9
	Chrome oxide brick production:			
	Casting Process			
	Milling (ball mill) (chromic oxide)	0.96 lb/ton of raw materials processed	Wet scrubber; 97% control efficiency	9
	Spray dryer (chromic oxide)	0.96 lb/ton of raw materials processed	Fabric filter; 97% control efficiency	9
	Pressing Process			
	Mixer (chromic oxide)	0.96 lb/ton of raw materials processed	Wet scrubber; 97% control efficiency	9
	Sodium dichromate manufacturing plants -		Factors expressed as total elemental chromium	
	Total process	30 lb/ton of dichromate produced 3.0 lb/ton of dichromate produced	Uncontrolled Controlled: 90% control efficiency	9 9

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	Kiln only	15 lb/ton of dichromate produced	Uncontrolled	9
		1.5 lb/ton of dichromate produced	Controlled; 90% control efficiency	9
	Chromic acid production			
	Chromic acid reactor, melter, and flaker	0.4 lb/ton of raw materials processed	Uncontrolled	9
		0.02 lb/ton of raw materials processed	Controlled; scrubber; 95% control efficiency	
	Chromic acid filter	2.8 lb/ton of raw materials processed	Uncontrolled	9
		0.03 lb/ton of raw materials processed	Controlled; scrubber; 99% control efficiency	9
	Packaging	1.4 lb/ton of raw materials processed	Uncontrolled	9
		0.07 lb/ton of raw materials processed	Controlled; scrubber; 95% control efficiency	9
	Hard chromium plating facility		Factors are in terms of chromic acid and are from one facility. All chromium is in the hexavalent form.	
	Hard plating tank	5.4E-05-2.9E-04 lb/hr.sq ft tank area		9
	Chromic acid anodizing tank	0.0019 lb/hr.sq ft of tank area		9
	Electric arc furnaces (EAF's)		Factors as total elemental chromium and represent emissions after capture equipment but prior to controls.	
	Stainless steel and special alloys	1.6-4.8 lb/ton of steel produced		9
	Mixed products including stainless steel and/or specialty alloys	0.33-1.0 lb/ton of steel produced		9
	Carbon and alloy steel	0.03-0.09 lb/ton of steel produced		9
	Carbon steel	0.03-0.09 lb/ton of steel produced		9
	Argon-oxygen decarburization vessels (AOD s)			
	Stainless and specialty alloys	0.87-1.2 lb/ton of steel produced		9
	Oil combustion		Chromium emissions most likely to exist as chromium sulfate, complex oxides of chromium and other metals, and chromium oxide.	

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	Distillate #2	23.8-29 pg/J (chromium emitted per unit of heat energy contained in the fuel)	Uncontrolled; measured	9
	Distillate #2	1.1-55 pg/J (chromium emitted per unit of heat energy contained in the fuel)	Uncontrolled; calculated	9
	Distillate #2	0.32-0.35 lb/1,000,000 gal (chromium emitted per mass of oil fired)	Uncontrolled; measured	9
	Residual #4	0.29 lb/1,000,000 gal (chromium emitted per mass of oil fired)	Uncontrolled; measured	9
	Residual #5	0.69 lb/1,000,000 gal (chromium emitted per mass of oil fired)	Uncontrolled; measured	9
	Residual #6	3.4 lb/1,000,000 gal (chromium emitted per mass of oil fired)	Uncontrolled; measured	9
	Residual	28.6 pg/J (chromium emitted per unit of heat energy contained in the fuel)	Uncontrolled; measured	9
	Residual	2.1-50 pg/J (chromium emitted per unit of heat energy contained in the fuel)	Uncontrolled; calculated	9
	Residual	5.7 pg/J (chromium emitted per unit of heat energy contained in the fuel)	Controlled; wet scrubber or ESP	9
	Coal combustion		Factors expressed as total chromium emitted per unit of heat energy in the fuel. Emissions most likely to exist as chromium sulfate, complex oxides of chromium and other metals, and chromium oxide.	
	Stoker; anthracite coal	102 - 648 pg/J heat input	Uncontrolled; measured	9
	Stoker; anthracite coal	200 pg/J heat input	Uncontrolled; calculated	9
	Stoker; anthracite coal	16.3 pg/J heat input	MC; calculated	9
	Pulverized; anthracite coal	60.2 pg/J heat input	ESP; calculated	9
	Pulverized; bituminous coal	1503 - 2600 pg/J heat input	Uncontrolled; calculated	9
	Pulverized; bituminous coal	825 pg/J heat input	Uncontrolled; measured	9
	Pulverized; bituminous coal	71.8 - 770 pg/J heat input	MC; calculated	9
	Pulverized; bituminous coal	5.3 pg/J heat input	MC; measured	9
	Pulverized; bituminous coal	45 - 60.2 pg/J heat input	ESP; calculated	9
	Pulverized; bituminous coal	2.5 - 3430 pg/J heat input	ESP; measured	9

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	Pulverized; bituminous coal	54.2 - 170 pg/J heat input	WS; calculated	9
	Pulverized; bituminous coal	0.26 - 5.3 pg/J heat input	WS; measured	9
	Pulverized; bituminous coal	7.8 pg/J heat input	MC/WS; measured	9
	Pulverized; bituminous coal	54 pg/J heat input	FBD; measured	9
	Cyclone; bituminous coal	495 - 645 pg/J heat input	Uncontrolled; measured	9
	Cyclone; bituminous coal	130 pg/J heat input	MC; calculated	9
	Cyclone; bituminous coal	8 - 9.3 pg/J heat input	ESP; calculated	9
	Cyclone; bituminous coal	290 - 2300 pg/J heat input	ESP; measured	9
	Cyclone; bituminous coal	14 pg/J heat input	WS; calculated	9
	Cyclone; bituminous coal	46 pg/J heat input	WS; measured	9
	Stoker; bituminous coal	38.3 - 2000 pg/J heat input	Uncontrolled; calculated	9
	Stoker; bituminous coal	8.1 - 129 pg/J heat input	Uncontrolled; measured	9
	Stoker; bituminous coal	16.3 - 590 pg/J heat input	MC; calculated	9
	Stoker; bituminous coal	26.8 - 1040 pg/J heat input	MC; measured	9
	Stoker; bituminous coal	58 pg/J heat input	ESP; measured	9
	Stoker; bituminous coal	66 pg/J heat input	FF; measured	
	Pulverized; lignite coal	253 pg/J heat input	MC; calculated	9
	Pulverized; lignite coal	29 - 32 pg/J heat input	MC; measured	9
	Pulverized; lignite coal	9.2 - 26.5 pg/J heat input	ESP; calculated	9
	Pulverized; lignite coal	8.6 pg/J heat input	ESP; measured	9
	Pulverized; lignite coal	75 pg/J heat input	WS; calculated	9
	Cyclone; lignite coal	245 - 430 pg/J heat input	MC; calculated	9
	Cyclone; lignite coal	5 - 17.8 pg/J heat input	ESP; calculated	9
	Cyclone; lignite coal	<3.3 pg/J heat input	ESP; measured	9
	Cyclone; lignite coal	40 pg/J heat input	WS; calculated	9
	Stoker; lignite coal	16.3 pg/J heat input	MC; calculated	9
	Stoker; lignite coal	13 pg/J heat input	MC; measured	9
	Stoker; lignite coal	<2.3 pg/J heat input	ESP; measured	9
	Cement Plants		Factors expressed as total chromium and in terms of the amount of cement produced.	
	Dry process kiln	26 lb/1000 tons	Uncontrolled	9
		0.004 - 0.03 lb/1000 tons	ESP	9
		0.003 - 0.03 lb/1000 tons	Fabric filter	9
	Dryers and grinders	10 lb/1000 tons	Uncontrolled	9
	Wet process kiln	25 lb/1000 tons	Uncontrolled	9
		0.004 - 0.03 lb/1000 tons	ESP	9
		0.01 - 0.03 lb/1000 tons	Fabric filter	9

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	Dryers and grinders	3.4 lb/1000 tons	Uncontrolled	9
	Clinker cooler	0.001 - 0.014 lb/1000 tons	Fabric filter	9
		0.005 - 0.01 lb/1000 tons	Gravel bed	9
		0.005 lb/1000 tons	Wet scrubber	9
	Municipal refuse incinerators		Factors expressed as total elemental chromium.	
	Multiple hearth			
	Refuse only	0.0077 lb/ton solid waste incinerated	Wet scrubber	9
	Refuse and sludge	0.0091 lb/ton solid waste incinerated	Wet scrubber	9
	Rocking grate	0.0048 lb/ton solid waste incinerated	Wet scrubber	9
	Travelling grate	0.0006 lb/ton solid waste incinerated	ESP	9
	Sewage sludge incinerators			
	Fluidized-bed 704 C	0.00008 lb/ton solid waste incinerated	Wet scrubber	
	816 C	0.00006 lb/ton solid waste incinerated	Wet scrubber	
	927 C	0.0004 lb/ton solid waste incinerated	Wet scrubber	
	Fluidized-bed	0.0006 lb/ton solid waste incinerated	Wet scrubber	
	Multiple hearth	0.014 lb/ton solid waste incinerated	Two controlled by wet scrubbers, one by a single-pass cyclonic scrubber.	
	Wood combustion	0.76 - 11.7 pg/J		9
	Fresh water utility cooling towers		Factors expressed as weight of pollutant per thermal energy input to the power plant associated with the cooling tower. Emissions expressed as total chromium.	
	Drift loss range of 0.1 to 0.2% (fraction of recirculating water emitted by design as draft)	2.5 pg/J		9
	Drift loss range of 0.002 to 0.005%	0.06 pg/J		9
	Asbestos mining and milling		Factors reported as total elemental chromium.	
	Mining and milling	0.14 lb/ton of asbestos produced	Degree of control unspecified	9

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	Mining	0.015 lb/ton of asbestos produced	Uncontrolled	9
		0.008 lb/ton of asbestos produced	50% controlled	9
		0.003 lb/ton of asbestos produced	80% controlled	9
	Milling	0.15 lb/ton of asbestos produced	Uncontrolled	9
		0.03 lb/ton of asbestos produced	80% controlled	9
		0.0015 lb/ton of asbestos produced	99% controlled	9
		0.000015 lb/ton of asbestos produced	Controlled	9
	Oil combustion, commercial and industrial	0.007 lb/1000 gal	Uncontrolled	2
	Utility cooling towers			
	Pre-1970	0.51 lb/MW output		2
	Post-1970	0.012 lb/MW output		2
	Bituminous coal combustion residential	0.004 lb/ton		2
	Residual oil combustion	1.2 E - 03 lb/ton burned		6
	Coal combustion, utility boilers			
	Pulverized dry bottom - bituminous coal	60.3 pg/J heat input	ESP	7
		170 pg/J heat input	Scrubber	7
		1300 pg/J heat input	Uncontrolled	7
	Pulverized wet bottom - bituminous coal	49 pg/J heat input	ESP	7
		80 pg/J heat input	ESP	7
	Cyclone - bituminous coal	46 pg/J heat input	Scrubber	7
	Stoker - bituminous coal	16.3 pg/J heat input	Multicyclones	7
	Pulverized - anthracite	60.2 pg/J heat input	ESP	7
	Stoker - anthracite	16.3 pg/J heat input	Multicyclones	7
	Pulverized dry bottom - lignite	26.3 pg/J heat input	ESP	7
	Pulverized wet bottom - lignite	3.2 pg/J heat input	Multicyclones	7
		21.6 pg/J heat input	ESP	7

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	Cyclone - lignite	17.8 pg/J heat input	ESP	7
		430 pg/J	Multicyclones	7
		2.1 pg/J	Scrubber	7
	Stoker - lignite	16.3 pg/J	Multicyclones	7
	Residual oil combustion			
	Tangential	5.7 pg/J	ESP	7
		28.6 pg/J	Uncontrolled	7
	Wall	5.7 pg/J	ESP	7
		28.6 pg/J	Uncontrolled	7
	Coal combustion - industrial boilers			
	Pulverized	71.3 pg/J heat input	Multicyclones	7
		54.2 pg/J heat input	Scrubber	7
	Stoker	16.3 pg/J heat input	Multicyclones	7
		38.3 pg/J heat input	Uncontrolled	7
	Oil combustion - industrial boilers			
	Tangential	5.7 pg/J heat input	Scrubber	7
		28.6 pg/J heat input	Uncontrolled	7
	Wall	5.7 pg/J heat input	Scrubber	7
		28.6 pg/J heat input	Uncontrolled	7
	Coal combustion - commercial boilers			
	Stoker	38.3 pg/J heat input	Uncontrolled	7
	Oil combustion - commercial boilers			
	Tangential - residual oil	50.0 pg/J heat input	Uncontrolled	7
	Wall - residual oil	50.0 pg/J heat input	Uncontrolled	7

Pollutant	Process	Emission Factor	Notes	Reference
Chromium (continued)	Oil combustion - commercial boilers -			
	Tangential - distillate oil	50.0 pg/J heat input	Uncontrolled	7
	Wall - distillate oil	50.0 pg/J heat input	Uncontrolled	7
	Coal combustion - residential boilers -			
	All furnace types - bituminous coal	71.3 pg/J heat input	Uncontrolled	7
	All furnace types - anthracite	66.2 pg/J heat input	Uncontrolled	7
	All furnace types - lignite	17.2 pg/J heat input	Uncontrolled	7
	Oil combustion - residential boilers -			
	All furnace types - distillate oil	1.1 pg/J heat input	Uncontrolled	7
Cresols	Coke production	0.048 lb/ton of coke produced		2
	Cresylic acid production -			
	Process	0.00190 lb/lb used		3
	Storage	0.00020 lb/lb used		3
	Fugitive	0.00040 lb/lb used		3
	Cresol production -			
	Process	0.00190 lb/lb used		3
	Storage	0.00020 lb/lb used		3
	Fugitive	0.00040 lb/lb used		3
Dichloroethane	Ethyl chloride production	9.45 kg/Mg produced		2
	Waste oil combustion	0.045 - 6.33 lb/1000 gal burned		3
Dichloromethane	Waste oil combustion	0.03 - 12.6 lb/1000 gal waste oil burned		3
Dipropylene glycol	Integrated circuit board manufacture	0.09 tons/100,000 sq ft product		4
DMF	Integrated circuit board manufacture -			
	Screening-hardener	0.04 tons/100,000 sq ft product		4

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Epichlorohydrin	Epichlorohydrin production -			
	Process vents	0.00047 g/kg produced	Controlled, not necessarily representative of emission rates from any particulate facility.	22
	Storage facilities	0.15 g/kg produced	Includes emissions from glycerin manufacture.	22
	Fugitive sources	0.62 g/kg produced	Valves, pumps, seals, uncontrolled	22
	Resin, elastomer and surfactant production, batch processes using epichlorohydrin as feedstock -			
	Process vents	0.56 g/kg produced	Not representative of emission rates at any particular facility	22
	Storage facilities	0.47 g/kg produced	Includes transfer operations	22
	Fugitive sources	7.10 g/kg produced	Pump seals, valves, compressors, flanges	22
Ethylene dibromide	Waste oil combustion	0.038 - 0.053 lb/1000 gal	Waste oil burned	3
Ethylene dichloride	EDC production, oxychlorination - air process			
	Absorber/stripper	3.24 kg/Mg produced 0.0650 kg/Mg produced 0.250 kg/Mg produced	Uncontrolled Thermal oxidizer Catalytic oxidizer	13 13 13
	Refrigerated condenser	2.40 kg/Mg produced 0.0480 kg/Mg produced	Uncontrolled Thermal oxidizer	13 13
	EDC production, oxychlorination -			
	Oxygen process	0.462 kg/Mg produced 0.0092 kg/Mg produced	Uncontrolled Thermal oxidizer	13 13
	EDC production, direct			
	Chlorination vent	1.08 kg/Mg produced 0.0216 kg/Mg produced 0.162 kg/Mg produced	Uncontrolled Thermal oxidizer Refrigerated condenser	13 13 13
	Column vents	3.00 kg/Mg produced 0.0600 kg/Mg produced	Uncontrolled Thermal oxidizer	13 13

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Ethylene dichloride (continued)	Storage vents - in process	0.0149 kg/Mg produced	Uncontrolled	13
		0.0003 kg/Mg produced	Thermal oxidizer	13
		0.0022 kg/Mg produced	Refrigerated condenser	13
	Storage vents - product	0.0733 kg/Mg produced	Uncontrolled	13
		0.0015 kg/Mg produced	Thermal oxidizer	13
		0.0110 kg/Mg produced	Refrigerated condenser	13
	Process fugitives	0.265 kg/Mg produced	Uncontrolled	13
		0.106 kg/Mg produced	Leak correction	13
	Vinyl chloride monomer production -			
	Heavy ends stream	0.6 - 0.8 kg/Mg produced	Uncontrolled	13
		0.016 kg/Mg produced	Incinerator	13
	Methyl chloroform production -			
	Hydrochlorinator vent condenser	8.5 kg/Mg produced		13
	Steam stripper vent condenser	0.5 kg/Mg produced		13
	Ethylene amine production	9.09 kg/Mg produced		13
	Trichloroethylene production	5.0 kg/Mg produced		13
	Perchloroethylene production -			
	Chlorination and oxychlorination	5.0 kg/Mg produced	Controlled	13
	Waste handling	0.026 kg/Mg produced	Uncontrolled	13
	Secondary emissions	0.00026 kg/Mg produced		13
	Vinylidene chloride production	5.7 kg/Mg produced	Controlled	13
	Ethyl chloride production	9.45 kg/Mg produced		13
	Polysulfide rubber production	33.8 kg/Mg produced	Controlled	13
	Use in leaded gasoline	0.14 mg/l produced		13
	Blending of gasoline	1 kg/Mg blended		13
	Gasoline tank car/truck loading -			
	Normal service	0.269 mg/l transferred		13
	Balance service	0.192 mg/l transferred		13
	Underground gasoline tank filling (splash filling)	0.26 mg/l transferred		13

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Ethylene dichloride (continued)	Vehicle refueling -			
	Displacement losses	0.21 mg/l transferred	Uncontrolled	13
		0.021 mg/l transferred	Controlled	13
Ethylene oxide	Ethylene oxide production -			
	Air - oxidation process:			
	Purge absorber vent	0.0005 - 1.0 g/kg	Uncontrolled	26
		0.04 g/kg	Thermal oxidation, 80% reduction	26
	Stripper vent	<0.7 g/kg	Uncontrolled	26
	Storage/Handling	2.6 g/kg	Uncontrolled	26
	Process fugitives	188 kg/day	Uncontrolled	26
		42 - 115 kg/day	I/M program	26
	Oxygen - oxidation process:			
	Main process purge vent	0.001 - 0.002 g/kg	Uncontrolled	26
	Carbon dioxide desorber vent	0.00006 - 0.75 g/kg	Uncontrolled	26
		0.06 g/kg	Carbonate flasher/vent condenser	26
	Stripper vent	<0.1 g/kg	Uncontrolled	26
		<0.002 g/kg	Various reabsorbers/incinerators/ water scrubbers/vent absorbers	26
	Storage/Handling	2.6 g/kg	Uncontrolled	26
	Process fugitives	148 g/kg	Uncontrolled	26
		52 - 91 g/kg	I/M program	26
	Cooling tower	0.07 g/kg	Uncontrolled	26
		0.014 g/kg	Increased stripper column effectiveness	26
Formaldehyde	Formaldehyde production -			
	Silver catalyst process			
	Absorber	0.38 kg/Mg of 37% solution produced	Uncontrolled	12
		0.0076 kg/Mg of 37% solution produced	Thermal oxidation	12
		0.076 kg/Mg of 37% solution produced	Flare	12

Pollutant	Process	Emission Factor	Notes	Reference
Formaldehyde	Product fractionator	0.33 kg/Mg of 37% solution produced	Uncontrolled	12
		0	Recycle to absorber	12
		0.017 kg/Mg of 37% solution produced	Water scrubber	12
	Start up vent	0.10 kg/Mg of 37% solution produced	Uncontrolled	12
	Formaldehyde storage	0.03 kg/Mg of 37% solution produced	Uncontrolled	12
		0.003 kg/Mg of 37% solution produced	Vent scrubber	12
		0.0006 kg/Mg of 37% solution produced	Thermal oxidation	12
	Handling	0.01 kg/Mg of 37% solution produced	Uncontrolled	12
		0.0004 kg/Mg of 37% solution produced	Vapor recovery	12
	Process fugitives	0.70 kg/Mg of 37% solution produced	Uncontrolled	12
		0.063 - 0.30 kg/Mg of 37% solution produced	Inspection/maintenance	12
	Formaldehyde production - metal oxide catalyst process			
	Absorber	0.47 kg/Mg of 37% solution produced	Uncontrolled	12
		0.009 kg/Mg of 37% solution produced	Thermal oxidation	12
	Formaldehyde storage	0.03 kg/Mg of 37% solution produced	Uncontrolled	12
		0.003 kg/Mg of 37% solution produced	Vent scrubber	12
	Handling	0.01 kg/Mg of 37% solution produced	Uncontrolled	12
		0.0004 kg/Mg of 37% solution produced	Vapor recovery	12
	Process fugitive	0.47 kg/Mg of 37% solution produced	Uncontrolled	12
		0.099 - 0.13 kg/Mg of 37% solution produced	Inspection/maintenance	12
	Urea - formaldehyde, melamine formaldehyde resin production			
	Process	0.15-1.5 kg/Mg of 37% formaldehyde used		12
	Formaldehyde storage	0.03-0.2 kg/Mg of 37% formaldehyde used		12
	Fugitive	0.03-0.2 kg/Mg of 37% formaldehyde used		12
	Phenol-formaldehyde resin production -			
	Process	0.15-1.5 kg/Mg of 37% formaldehyde used		12
	Formaldehyde storage	0.03-0.2 kg/Mg of 37% formaldehyde used		12
	Fugitive	0.03-0.2 kg/Mg of 37% formaldehyde used		12

Pollutant	Process	Emission Factor	Notes	Reference
Formaldehyde (continued)	Polyacetal resin production -			
	Process	0.09-0.37 kg/Mg of 37% formaldehyde used		12
	Formaldehyde storage	0.02-0.03 kg/Mg of 37% formaldehyde used		12
	Fugitive	0.02-0.36 kg/Mg of 37% formaldehyde used		12
	Hexamethylenetetramine production -			
	Process	<0.39 kg/Mg of 37% formaldehyde used		12
	Formaldehyde storage	0.05 kg/Mg of 37% formaldehyde used		12
	Fugitive	0.11 kg/Mg of 37% formaldehyde used		12
	Pentaerythritol production -			
	Process	1.3-2.7 kg/Mg of 37% formaldehyde used		12
	Formaldehyde storage	0.002-0.33 kg/Mg of 37% formaldehyde used		12
	Fugitive	0.14-0.15 kg/Mg of 37% formaldehyde used		12
	1,4-Butanediol production -			
	Process	<0.74 kg/Mg of 37% formaldehyde used		12
	Formaldehyde storage	0.005-0.2 kg/Mg of 37% formaldehyde used		12
	Fugitive	0.005-0.2 kg/Mg of 37% formaldehyde used		12
	Trimethylolpropane production -			
	Process	0.074 kg/Mg of 37% formaldehyde used		12
	Formaldehyde storage	0.01 kg/Mg of 37% formaldehyde used		12
	Fugitive	0.01 kg/Mg of 37% formaldehyde used		12
	Phthalic anhydride production -	2.1 kg/Mg produced	Uncontrolled	12
		0.074 kg/Mg produced	Direct incineration	12
	Solid urea production -			
	Fluidized bed prilling (agricultural grade)	0.095 kg/Mg produced	Uncontrolled	12
		0.0004 kg/Mg produced	Controlled	12
	Drum granulation	0.0055 kg/Mg produced	Uncontrolled	12
		0.0027 kg/Mg produced	Controlled	12

Pollutant	Process	Emission Factor	Notes	Reference
Formaldehyde	Stationary internal combustion engines -			
	Gas turbines	4.0 ng/J heat input		12
	Gas fired reciprocating engines	5.7 ng/J heat input		12
	Process heaters	1.9 ng/J heat input		12
	Automobiles -			
	Catalyst	0.05 - 0.83 g/gallon		12
	Non-catalyst	0.83 g/gallon		12
	Diesel	0.33 g/gallon		12
	Petroleum refining -			
	Catalytic cracking	1.0 - 2.2 kg/1000 bbl feed		12
	Coking	0.54 kg/1000 bbl feed		12
	Integrated circuit board manufacture	0.50 ton/100,000 sq ft product		4
	Hot mix asphalt plants	0.00015 lb/ton asphalt		3
	Wood combustion -			
	Commercial/industrial	0.48 lb/ton		3
	Residential woodstoves	0.46 - 0.48 lb/ton		2, 3
	Residential fireplaces	3.0 lb/ton		3
	Bituminous coal combustion -			
	Residential	0.0024 lb/ton burned		2
	Utility boiler - pulverized dry bottom	59.3 pg/J heat input	Multicyclone or scrubber	7
	Utility boiler - pulverized wet bottom	35.3 pg/J heat input	Multicyclone or scrubber	7
	Utility boiler - cyclone	56.8 pg/J heat input	Multicyclone	7
	Utility boiler - stoker	37.4 pg/J heat input	Multicyclone	7
	Utility boiler - stoker	60.2 pg/J heat input	Uncontrolled	7
	Coal combustion	0.03 lb/ton	Uncontrolled	2
		0.002 lb/ton	ESP	2

Pollutant	Process	Emission Factor	Notes	Reference
Formaldehyde (continued)	Oil combustion, commercial/ industrial	0.033 lb/1000 gal	Uncontrolled	2
Gasoline vapors	Vehicle fueling	5.0 g/gallon	Uncontrolled	1
	Underground tank filling	3.0 g/gallon	Uncontrolled	1
	Underground tank breathing losses	0.5 g/gallon	Uncontrolled	1
Gaseous fluorides	Aluminum: anode baking furnace	0.9 lb/ton produced 0.009 - 0.004 lb/ton produced	Uncontrolled Controlled	4 4
	Aluminum: prebake cell	24 lb/ton produced 0.2 - 3.4 lb/ton produced	Uncontrolled Controlled	4 4
	Aluminum: Soderberg stud cell	33 lb/ton produced 0.3 - 4.9 lb/ton produced	Uncontrolled Controlled	4 4
Lead	Utility boilers - pulverized dry bottom	39.1 pg/J heat input 10.4 pg/J heat input 53 pg/J heat input	ESP, bituminous coal Scrubber, bituminous coal Uncontrolled, bituminous coal	7 7 7
	Utility boilers - pulverized wet bottom	53 pg/J heat input	ESP, bituminous coal	7
	Utility boilers - cyclone	5.0 pg/J heat input	ESP, bituminous coal	7
	Utility boilers - stoker	610 pg/J heat input	Multicyclone, bituminous coal	7
	Utility boilers - pulverized	39.8 pg/J heat input	ESP, anthracite coal	7
	Utility boilers - stoker	610 pg/J heat input	Multicyclone, anthracite coal	7
	Utility boilers - pulverized dry bottom	2.5 pg/J heat input	ESP, lignite coal	7
	Utility boilers - pulverized wet bottom	4.6 pg/J heat input	ESP, lignite coal	7
	Utility boilers - cyclone	112 pg/J heat input 154 pg/J heat input	ESP, lignite coal Scrubber, lignite coal	7 7
	Utility boilers - stoker	121 pg/J heat input	Multicyclone, lignite coal	7
	Utility boilers - tangential, wall	4.0 pg/J heat input 20.0 pg/J heat input	Residential, ESP Residential, ESP	7 7

Pollutant	Process	Emission Factor	Notes	Reference
Lead (continued)	Industrial boiler -			
	Coal - pulverized	161 pg/J heat input	ESP	7
		8.8 pg/J heat input	Multicyclone	7
		121 pg/J heat input	Scrubber	7
		121 pg/J heat input	Uncontrolled	7
	Coal - stoker	282 pg/J heat input	Multicyclone, also commercial boilers	7
		4.1 pg/J heat input	Uncontrolled	7
	Oil - tangential and wall	20.4 pg/J heat input	Scrubber, also commercial boilers	7
		4.1 pg/J heat input	Uncontrolled, also commercial boilers	7
	Residential boilers -			
	All	359 pg/J heat input	Bituminous coal	7
	All	265 pg/J heat input	Anthracite coal	7
	All	17.2 pg/J heat input	Lignite coal	7
	All	9.5 pg/J heat input	Distillate oil	7
	Gray iron foundries -			
	Cupola	0.1 - 1.1 lb/ton produced	Uncontrolled	26
	Reverberatory furnace	0.012 - 0.14 lb/ton produced	Uncontrolled	26
	Electric induction	0.009 - 0.1 lb/ton produced	Uncontrolled	26
Manganese	Submerged-arc electric furnaces producing ferromanganese and silicomanganese -			
	Ferromanganese, open furnace	13.2 lb/ton product	Uncontrolled	25
	Ferromanganese, semisealed	5.2 lb/ton product	Uncontrolled	25
	Ferromanganese, sealed	19.2 lb/ton product	Uncontrolled	25
	Silicomanganese	46.4 lb/ton product	Uncontrolled	25
	Ferromanganese, open furnace	0.4 lb/ton product	Scrubber	25
	Ferromanganese, semisealed	0.08 lb/ton product	Scrubber	25
	Ferromanganese, sealed	0.008 lb/MWhr	Scrubber	25
	Silicomanganese, open furnace	0.11 lb/MWhr	Scrubber	25
	Silicomanganese, semisealed	0.032 lb/ton product	Scrubber	25
	Silicomanganese, sealed	0.002 lb/MWhr	Scrubber	25
	Synthetic manganese production -			
	Drying and grinding	8.9 lb/ton material processed	Uncontrolled	25
		0.009 lb/ton processed	Fabric filter	25

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Manganese (continued)	Synthetic manganese production -			
	Roasting	110 lb/ton processed	Uncontrolled	25
		0.22 lb/ton processed	Fabric filter	25
	Packaging/handling	5.4 lb/ton processed	Uncontrolled	25
		0.0054 lb/ton processed	Fabric filter	25
	Iron blast furnaces -			
	Slips	0.261 lb/slip		25
	Casthouse	0.0018 lb/ton iron		25
	Sintering	0.134 lb/ton sinter	Uncontrolled	25
		0.002 lb/ton sinter	Dry ESP	25
		0.0192 lb/ton sinter	Wet ESP	25
		0.0056 lb/ton sinter	Scrubber	25
		0.012 lb/ton sinter	Cyclone	25
	Sinter discharge	0.08 lb/ton sinter	Uncontrolled	25
		0.0012 lb/ton sinter	Fabric filter	25
	Windbox and discharge	0.0036 lb/ton sinter	Fabric filter	25
	Open hearth furnaces -			
	Melting/refining	0.078 lb/ton pig iron	Uncontrolled	25
		0.001 lb/ton	ESP	25
	Teeming	0.00026 lb/ton	Uncontrolled	25
	Basic oxygen furnace -			
	Melting/refining	0.288 lb/ton steel	Uncontrolled	25
		0.013 lb/ton steel	ESP	25
		0.009 lb/ton steel	Scrubber	25
	Charging	0.006 lb/ton steel	Uncontrolled, at source	25
	Tapping	0.0092 lb/ton steel	Uncontrolled, at source	25
	Hot metal transfer	0.0004 lb/ton	Uncontrolled, at source	25
	Chemical manufacture -			
	Ore drying/grinding	8.9 lb/ton material processed	Uncontrolled	25
		0.009 lb/ton material processed	Fabric filter	25

Pollutant	Process	Emission Factor	Notes	Reference
Manganese (continued)	Chemical manufacture -			
	Ore roasting	110 lb/ton	Uncontrolled	25
		0.22 lb/ton	Fabric filter	25
	Electric arc furnaces -			
	Melt/refine carbon steel	1.33 lb/ton product	Uncontrolled	25
	Charging, tapping, slagging	0.049 lb/ton	Uncontrolled, at roof monitor	25
	Iron foundries -			
	Cupola	0.25 lb/ton iron	Uncontrolled	25
		0.003 lb/ton iron	Fabric filter	25
		0.075 lb/ton iron	Impingement scrubber	25
	Electric arc furnace	0.95 lb/ton iron	Uncontrolled	25
		0.0015 lb/ton iron	Fabric filter	25
	Induction furnace	0.0225 lb/ton iron	Uncontrolled	25
	Steel foundries -			
	Electric arc furnace	0.52 lb/ton steel	Uncontrolled	25
		0.026 lb/ton	ESP	25
		0.013 lb/ton	Venturi scrubber	25
		0.0008 lb/ton	Fabric filter	25
	Induction furnace	0.004 lb/ton	Uncontrolled	25
	Battery manufacture -			
	Ore grinding	30 lb/ton material processed	Uncontrolled	25
		0.03 lb/ton material processed	Fabric filter	25
	Screening	1.0 lb/ton material processed	Uncontrolled	25
		0.001 lb/ton material processed	Fabric filter	25
	Storage/handling	4.4 lb/ton material processed	Uncontrolled	25
		0.0044 lb/ton material processed	Fabric filter	25
	Industrial boilers -			
	Pulverized	29.4 pg/J heat input	Multicyclone, bituminous coal	25
	Stoker	47.3 pg/J heat input	Scrubber, bituminous coal	25
	Tangential, wall	1.3 pg/J heat input	Scrubber, residual oil	25
		6.5 pg/J heat input	Uncontrolled, residual oil	25

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Manganese (continued)	Commercial/institutional boilers -			
	Stoker	111 pg/J heat input	Uncontrolled, bituminous coal	25
	All	6.5 pg/J heat input	Residual oil	25
	All	0.6 pg/J heat input	Distillate oil	25
	Residential boilers -			
	All	2150 pg/J heat input	Uncontrolled, bituminous coal	25
	All	66.2 pg/J heat input	Uncontrolled, anthracite coal	25
	All	430 pg/J heat input	Uncontrolled, lignite coal	25
	All	0.6 pg/J heat input	Uncontrolled, distillate oil	25
	Wood combustion, residential	1.0 lb/ton burned		3
	Cement plants -			
	Dry process, kiln	122 lb/1000 ton cement produced	Uncontrolled	25
		0.021-0.125 lb/1000 ton cement produced	ESP	25
		0.013-0.124 lb/1000 ton cement produced	Fabric filter	25
	Dryer/grinder	48 lb/1000 ton cement produced	Uncontrolled	25
	Wet process, kiln	114 lb/1000 ton cement produced	Uncontrolled	25
		0.02-0.142 lb/1000 ton cement produced	ESP	25
		0.049-0.132 lb/1000 ton cement produced	Fabric filter	25
	Dryer/grinder	16 lb/1000 tons cement produced	Uncontrolled	25
	Clinker cooler	0.005-0.061 lb/1000 ton cement produced	Fabric filter	25
		0.023-0.045 lb/1000 ton cement produced	Gravel bed	25
		0.022 lb/1000 ton cement produced	Wet scrubber	25
	Municipal refuse incinerators	0.05 lb/ton waste incinerated	Uncontrolled	25
		0.01 lb/ton waste incinerated	ESP	25
	Sewage sludge incinerator, multiple hearth	0.004 lb/ton waste incinerated	Wet scrubber	25
	Sewage sludge incinerator, fluidized bed	0.0006 lb/ton waste incinerated	Wet scrubber	25
	Waste oil combustion	0.0075 - 0.14 lb/1000 gal		3

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Mercury	Mining	0.01 lb/ton ore mined		8
	Primary ore processing -			
	Smelter	0.031 lb/ton ore processed	Uncontrolled	8
	Roasting	0.02 lb/ton ore processed	Uncontrolled	8
	Retort	0.002 lb/ton ore processed	Uncontrolled	8
	Secondary production	40 lb/ton mercury processed	Uncontrolled	8
	Electrolytic chlorine production, hydrogen stream	0.002-0.01 lb/ton of chlorine produced	Uncontrolled	8
	Coal combustion	0.098 - 0.82 lb/1000 tons		8
	Oil combustion	0.000008 - 0.002 lb/1000 gal		8
	Municipal waste incinerators	0.002 lb/ton		2
	Sewage sludge incinerators	14 - 18 lb/1000 tons		2
	Waste oil combustion	1.68 - 3.04 lb/1000 gal		3
Methylene chloride	Vapor degreasing	0.56 kg/kg MC consumed	Use of MC divided equally between open top and conveyorized degreasing processes.	21
	Photoresist stripping	0.57 kg/kg of fresh solvent		21
	Integrated circuit board manufacturer -			
	Stripper	1.92 ton/100,000 sq ft of product		4
Nickel	Primary smelting of nickel ore -		Factors expressed as total nickel.	
	Rotary dryers	0.042-0.56 lb/ton of nickel produced	Cyclone/scrubber	10
	Crusher house	0.012-0.092 lb/ton of nickel produced	Fabric filter	10
	Day bin	0.00065-0.0019 lb/ton of nickel produced	Fabric filter	10
	Calciners	0.46 lb/ton of nickel produced	ESP	10
	Skip hoists	0.027-0.067 lb/ton of nickel produced	Fabric filter	10
	Ore melter/roaster combination	0.054-0.092 lb/ton of nickel produced	Fabric filter	10

Pollutant	Process	Emission Factor	Notes	Reference
Nickel (continued)	Primary smelting of nickel ore -			
	Refining furnace	0.013 lb/ton of nickel produced	Fabric filter	10
	Open hearth furnace -			
	Melt furnace	0.0011 lb/ton of steel produced	ESP	10
		0.0085 lb/ton of steel produced	Uncontrolled	10
	Battery manufacturing	8.8 lb/ton of nickel processed		10
	Nonferrous metals production sources -			
	Nickel-copper, copper-nickel	2 lb/ton of nickel charged	Fabric filter	10
	Super alloys	2 lb/ton of nickel charged	Fabric filter	10
	Permanent magnet alloys	2 lb/ton of nickel charged	Fabric filter	10
	Electrical alloys	2 lb/ton of nickel charged	Fabric filter	10
	Other nonferrous alloys	2 lb/ton of nickel charged	Fabric filter	10
	Oil combustion -			
	Domestic crude	20-500 lb/1,000,000 gal oil		10
	Foreign crude	200 lb/1,000,000 gal oil		10
	Residual #6	83 lb/1,000,000 gal oil		10
	Residual #5	64 lb/1,000,000 gal oil		10
	Residual #4	48 lb/1,000,000 gal oil		10
	Residual	63-1056 pg/J (nickel emitted per unit of heat energy in fuel)		10
	Residual	57-63 pg/J (nickel emitted per unit of heat energy in fuel)	Controlled; ESP or scrubber	10
	Distillate #2	0.38-0.41 lb/1,000,000 gal oil		10
	Distillate #2	290 pg/J (nickel emitted per unit of heat energy in fuel)		10
	Distillate #2	13-446 pg/J (nickel emitted per unit of heat energy in fuel)		10

Pollutant	Process	Emission Factor	Notes	Reference
Nickel (continued)	Coal combustion -		Factors expressed as total nickel emitted per unit per energy in fuel.	
	Stoker, anthracite coal	135 - 470 pg/J heat input	Uncontrolled; measured	10
		29 pg/J heat input	MC; calculated	10
	Pulverized, anthracite coal	30 pg/J heat input	ESP; calculated	10
	Pulverized, bituminous coal	130 - 2900 pg/J heat input	Uncontrolled; calculated	10
		1045 pg/J heat input	Uncontrolled; measured	10
		709 - 870 pg/J heat input	MC; calculated	10
		16 pg/J heat input	MC; measured	10
		50 - 62 pg/J heat input	ESP; calculated	10
		4.3 - 2480 pg/J heat input	ESP; measured	10
		213 - 227 pg/J heat input	WS; calculated	10
		0.48 - 133 pg/J heat input	WS; measured	10
	Cyclone, bituminous coal	147 pg/J heat input	MC; calculated	10
		2 - 11 pg/J heat input	ESP; calculated	10
		429 - 1350 pg/J heat input	ESP; measured	10
		470 pg/J heat input	Uncontrolled; measured	10
		38 pg/J heat input	WS; calculated	10
		20 pg/J heat input	WS; measured	10
	Stoker, bituminous coal	400 - 2200 pg/J heat input	Uncontrolled; calculated	10
		13 - 1463 pg/J heat input	Uncontrolled; measured	10
		670 pg/J heat input	MC; calculated	10
		13 - 2230 pg/J heat input	MC; measured	10
		71 pg/J heat input	FF; measured	10
	Pulverized, lignite coal	228 pg/J heat input	MC; calculated	10
		115 - 263 pg/J heat input	MC; measured	10
		8.3 - 13 pg/J heat input	ESP; calculated	10
		<68 pg/J heat input	ESP; measured	10
		161 pg/J heat input	WS; calculated	10
	Cyclone, lignite coal	4.5 pg/J heat input	ESP; calculated	10
		<47 pg/J heat input	ESP; measured	10
		87 pg/J heat input	WS; calculated	10
		221 - 320 pg/J heat input	MC; calculated	10
	Stoker, lignite coal	276 pg/J heat input	MC; measured	10
		<38 pg/J heat input	ESP; measured	10
	Wood combustion	2 - 65 pg/J heat input		10

Pollutant	Process	Emission Factor	Notes	Reference
Nickel (continued)	Fresh water utility cooling tower -		Factors expressed as weight of pollutant per thermal energy input to power plant associated with the cooling tower.	
	Drift loss range of 0.1 to 0.2%	16 pg/J heat input		10
	Drift loss range of 0.002 to 0.005%	0.34 pg/J heat input		10
	Major cement plant sources -		Factors expressed as total nickel and in terms of amount of raw material feed input.	
	Dry cement process			
	Kiln	0.3 lb/1000 tons	Fabric filter	10
	Feed to initial grinding mill	0.01 lb/1000 tons	Fabric filter	10
	Air separator after initial grinding mill	0.001 lb/1000 tons	Fabric filter	10
	Raw material grinding mills	0.0006 lb/1000 tons	Fabric filter	10
	Feed to finish grinding mill	0.01 lb/1000 tons	Fabric filter	10
	Air separator after finish grinding mill	0.006 lb/1000 tons	Fabric filter	10
	Wet cement process			
	Kiln	0.2 to 2 lb/1000 tons	ESP	10
	Clinker cooler	0.004 lb/1000 tons 0.1 lb/1000 tons 0.2 lb/1000 tons	Fabric filter ESP Two fabric filters in parallel	10 10 10
	Finishing grinding mill after air separator	0.004 lb/1000 tons	Fabric filter	10
	Municipal refuse incinerators -		Factors expressed as total elemental nickel.	
	Refuse only	0.003 lb/ton of solid waste incinerated	Wet scrubber	10
	Refuse and sludge	0.005 lb/ton of solid waste incinerated	Wet scrubber	10

Pollutant	Process	Emission Factor	Notes	Reference
Nickel (continued)	Sewage sludge incinerators -			
	Multiple hearth	0.003 lb/ton of solid waste incinerated	Wet scrubber	10
	Fluidized bed	0.0003 lb/ton of solid waste incinerated	Wet scrubber	10
	Uncontrolled multiple-hearth or fluidized-bed unit	0.15 lb/ton of solid waste incinerated	Wet scrubber	10
	Secondary processing of nickel-bearing scrap -		Factors apply to individual melting furnaces	
	Stainless steel	10 lb/ton of nickel charged 0.6 lb/ton of steel produced	Controlled Controlled	10 10
	Nickel alloy steels	10 lb/ton of nickel charged	Controlled	10
	Iron and steel scrap	0.0015 lb/ton of iron and steel produced	Controlled	10
	Other nickel alloys	2 lb/ton of nickel charged	Controlled	10
	Copper base alloys	2 lb/ton of nickel charged	Controlled	10
	Electrical alloys	2 lb/ton of nickel charged	Controlled	10
	Cast iron	20 lb/ton of nickel charged	Uncontrolled	10
	Steel manufacturing operations -		Factors expressed as total nickel.	
	Open hearth furnace	0.00018 lb/ton of steel produced	ESP	10
	Open hearth fugitive emissions	0.00005 lb/ton of steel produced	Uncontrolled	10
	Basic oxygen process furnace	0.000018 lb/ton of steel produced	Scrubber	10
	Basic oxygen process fugitives	0.0001 lb/ton of steel produced	Uncontrolled	10
	Electric arc furnace (carbon steel)	0.0083 lb/ton of steel produced 0.000013 - 0.000084 lb/ton of steel produced	Uncontrolled Fabric filter	10 10
	Electric arc furnace (alloy steel)	0.025 lb/ton of steel produced 0.000039 - 0.00025 lb/ton of steel produced	Uncontrolled Fabric filter	10 10

Pollutant	Process	Emission Factor	Notes	Reference
Nickel (continued)	Steel manufacturing operations -			
	Electric arc furnace fugitive emissions (carbon steel)	0.00054 lb/ton of steel produced 0.00011 lb/ton of steel produced	Uncontrolled Hoods and fabric filter	10 10
	Electric arc furnace fugitive (alloy steel)	0.0016 lb/ton of steel produced 0.00032 lb/ton of steel produced	Uncontrolled Hoods and fabric filter	10 10
	Electric arc furnace (stainless steel)	0.3 lb/ton of steel produced 0.003 lb/ton of steel produced	Uncontrolled Fabric filter	10 10
	Electric arc furnace fugitive emissions (stainless steel)	0.036 lb/ton of steel produced 0.0072 lb/ton of steel produced	Uncontrolled Hoods and fabric filter	10 10
	Argon oxygen decarburization vessel (stainless steel)	0.32 lb/ton of steel produced 0.064 lb/ton of steel produced	Uncontrolled Fabric filter	10 10
	Coke ovens	0.0016 lb/ton of coal produced	Uncontrolled	10
	Asbestos mining	0.000018 lb/ton	Controlled	10
	Oil combustion -			
	U.S. crude oils Imported crude oils, average Foreign crude oils Foreign residual oils	0.01 - 0.5 lb/1000 gal 0.07 lb/1000 gal 0.01 - 0.4 lb/1000 gal 0.03 - 0.5 lb/1000 gal	1.4 - 64 ppm nickel content 9.3 - 28.9 ppm nickel content 1.8 - 59 ppm nickel content 4 - 61.2 ppm nickel content	8 8 8 8
	U.S boilers			
	Distillate oil - residential units	0.0004 - 0.0005 lb/1000 gal		8
	#6 Residual oil + comercial units	0.08 lb/1000 gal	48.5 ppm nickel content	8
	#5 Residual oil - comercial units	0.06 lb/1000 gal	31 ppm nickel content	8
	#4 Residual oil - comercial units	0.05 lb/1000 gal	18 ppm nickel content	8
	Waste incineration -			
	Lubricating oil	0.07 lb/1000 gal of lubricating oil	Emission factor for nickel oxides	8

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Nickel (continued)	Coal combustion - utility boilers -			
	Pulverized dry bottom, bituminous coal	30.1 pg/J 22.1 pg/J 130 pg/J	ESP Scrubber Uncontrolled	7 7 7
	Pulverized wet bottom, bituminous coal	24.3 pg/J	ESP	7
	Cyclone, bituminous coal	20 pg/J 130 pg/J	ESP Uncontrolled	7 7
	Stoker, bituminous coal	29.2 pg/J	Multicyclones	7
	Pulverized, anthracite coal	30.1 pg/J	ESP	7
	Stoker, anthracite coal	29.2 pg/J	Multicyclones	7
	Pulverized dry bottom, lignite coal	13.2 pg/J	ESP	7
	Pulverized wet bottom, lignite coal	2.0 pg/J	ESP	7
	Cyclone, lignite coal	4.5 pg/J 320 pg/J	ESP Multicyclones	7 7
	Stoker, lignite coal	29.2 pg/J	Multicyclones	7
	Oil combustion - utility boilers -			
	Tangential, residual oil	[illegible] pg/J 287 pg/J	ESP Uncontrolled	7 7
	Wall, residual oil	57.2 pg/J 287 pg/J	ESP Uncontrolled	7 7
	Coal combustion - industrial boilers -			
	Pulverized, coal	39.0 pg/J heat input 26.0 pg/J heat input	Multicyclones Scrubber	7 7
	Stoker, coal	29.2 pg/J heat input 68.4 pg/J heat input	Multicyclones Uncontrolled	7 7

Pollutant	Process	Emission Factor	Notes	Reference
Nickel (continued)	Oil combustion - industrial boilers -			
	Tangential, oil	62.8 pg/J heat input	Scrubber	7
		31.4 pg/J heat input	Uncontrolled	7
	Wall, oil	62.8 pg/J heat input	Scrubber	7
		31.4 pg/J heat input	Uncontrolled	7
	Coal combustion - commercial boilers -			
	Stoker, coal	68.4 pg/J heat input	Uncontrolled	7
	Oil combustion - commercial boilers -			
	Tangential, residual oil	804 pg/J heat input	Uncontrolled	7
	Tangential, distillate oil	112 pg/J heat input	Uncontrolled	7
	Wall, residual oil	804 pg/J heat input	Uncontrolled	7
	Wall, distillate oil	112 pg/J heat input	Uncontrolled	7
	Coal combustion - residential boilers -			
	All furnaces, bituminous coal	71.8 pg/J heat input	Uncontrolled	7
	All furnaces, anthracite coal	66.2 pg/J heat input	Uncontrolled	7
	All furnaces, lignite coal	17.2 pg/J heat input	Uncontrolled	7
	Oil combustion - residential boilers -			
	All furnaces, distillate oil	103 pg/J heat input	Uncontrolled	7
Perchloroethylene (PCE)	Clothes cleaning -			
	Coin-operated	15.7 kg PCE/100 kg clothes cleaned		18
	Commercial	9.5 kg PCE/100 kg clothes cleaned		18
	Industrial	10.4 kg PCE/100 kg clothes cleaned		18
	PCE production	0.002 lb/lb PCE produced		6
	Storage and handling	2.3 lb/1000 gal		7
	Degreasing -			
	Open top vapor degreasing	0.78 kg/kg PCE consumed		18

Pollutant	Process	Emission Factor	Notes	Reference
Perchloroethylene (continued)	Degreasing -			
	Conveyorized degreasing	0.85 kg/kg PCE consumed		18
	Weighted average (use of PCE divided equally between open top and conveyorized degreasing)	0.72 kg/kg PCE consumed		18
	Accounting for recycled solvent	0.92 kg/kg fresh PCE used in degreasing		18
Phenol	Caprolactum production	0.00144 lb/lb phenol used		3
	Phenol - formaldehyde resin production -			
	Process	0.00035 lb/lb used		3
	Storage	0.00002 lb/lb used		3
	Fugitive	0.00013 lb/lb used		3
	Phenol production -			
	Process	0.00178 lb/lb produced		3
	Storage	0.00003 lb/lb produced		3
	Fugitive	0.00041 lb/lb produced		3
	Wood combustion - residential -			
	Woodstove	2.0 lb/ton		3
	Fireplace	2.0 lb/ton		3
	Wood combustion - commercial and industrial	2.0 lb/ton		3
Phosgene	Phosgene plant	2.35 - 34.8 lb/1,000,000 lb processed		23
	Diisocyanate plant using phosgene produced on site -			
	Phosgene production	2.35-34.8 lb/1,000,000 lb phosgene produced		23
	Toluene diisocyanate production	1.18-14.1 lb/1,000,000 lb phosgene produced		23
	Polycarbonate plant using phosgene produced on site -			
	Phosgene production	2.35-34.8 lb/1,000,000 lb phosgene produced		23
	Polycarbonate production	0.55-6.2 lb/1,000,000 lb phosgene produced		23

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Phosgene (continued)	Herbicide and pesticide plant using phosgene produced on site -			
	Phosgene production	2.33-34.8 lb/1,000,000 lb phosgene produced		23
	Herbicide and pesticide production	0.55-6.4 lb/1,000,000 lb phosgene produced		23
Polychlorinated biphenyls	Waste oil combustion	0.0075 lb/gal waste oil burned		3
Polycyclic organic matter	Coal combustion	0.000076 lb/ton burned	Uncontrolled	2
		0.000007 lb/ton burned	Multicyclone	2
		0.00004 lb/ton burned	ESP	2
		0.14 lb/ton burned	Residential; bituminous coal	2
	Oil combustion - commercial and industrial	0.000175 lb/1000 gal	Uncontrolled	2
	Charcoal manufacturing	0.007 lb/ton		2
	Coke production	0.01 lb/ton coke		2
	Incineration of scrap wood -			
	Industrial boilers	0.002 g/kg		2
	Residential boilers	0.27 g/kg		2
	Municipal waste incinerators	<0.001 lb/ton		2
	Wood combustion - residential -			
	Woodstoves	0.54 lb/ton		2
		0.55 lb/ton		3
	Fireplaces	0.058 lb/ton		2
	Hot-mix asphalt plants	0.00026 lb/ton		3
	Wood combustion - commercial, industrial	0.004 lb/ton		3
	Coal combustion - utility boilers -			
	Pulverized dry bottom, bituminous coal	1.0 pg/J heat input	ESP	7
		1.2 pg/J heat input	Multicyclones	7
	Pulverized wet bottom, bituminous coal	1.0 pg/J heat input	ESP	7
		1.0 pg/J heat input	Multicyclones	7

Pollutant	Process	Emission Factor	Notes	Reference
Polycyclic organic matter (continued)	Coal combustion - utility boilers -			
	Cyclone, bituminous coal	1.0 pg/J heat input	ESP	7
	Stoker, bituminous coal	1.2 pg/J heat input	Multicyclones	7
	Stoker, anthracite coal	1.2 pg/J heat input	Multicyclones	7
	Pulverized dry bottom, lignite coal	1.1 pg/J heat input	ESP	7
	Pulverized wet bottom, lignite coal	0.09 pg/J heat input	ESP	7
	Cyclone, lignite coal	1.1 pg/J heat input 1.1 pg/J heat input	ESP Multicyclones	7 7
	Stoker, lignite coal	1.1 pg/J heat input	Multicyclones	7
	Oil combustion - utility boilers -			
	Tangential, residential oil	0.04 pg/J heat input 0.09 pg/J heat input	ESP Uncontrolled	7 7
	Wall, residual oil	0.04 pg/J heat input 0.09 pg/J heat input	ESP Uncontrolled	7 7
	Coal combustion - industrial boilers -			
	Pulverized, coal	9.5 pg/J heat input	Multicyclones	7
	Stoker, coal	13.2 pg/J heat input 31.0 pg/J heat input	Multicyclones Uncontrolled	7 7
	Oil combustion - industrial boilers -			
	Tangential, oil	0.5 pg/J heat input	Uncontrolled	7
	Wall, oil	0.8 pg/J heat input	Uncontrolled	7
	Coal combustion - commercial boilers -			
	Pulverized, coal	19.1 pg/J heat input	Uncontrolled	7
	Stoker, coal	45.2 pg/J heat input	Uncontrolled	7

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Polycyclic organic matter (continued)	Oil combustion - commercial boilers -			
	Tangential, residual oil	44.0 pg/J heat input	Uncontrolled	7
	Wall, residual oil	44.0 pg/J heat input	Uncontrolled	7
	Tangential, distillate oil	20.0 pg/J heat input	Uncontrolled	7
	Wall, distillate oil	30.0 pg/J heat input	Uncontrolled	7
	Coal combustion - residential boilers -			
	All furnaces, bituminous coal	1737 pg/J heat input	Uncontrolled	7
	All furnaces, anthracite coal	1032 pg/J heat input	Uncontrolled	7
	All furnaces, lignite coal	3600 pg/J heat input	Uncontrolled	7
	Oil combustion - residential boilers -			
	All furnaces, distillate oil	10.3 pg/J heat input	Uncontrolled	7
Selenium	Utility boilers -			
	Pulverized dry bottom	13.0 pg/J heat input	Scrubber, bituminous coal	7
	Pulverized wet bottom	16.3 pg/J heat input	ESP, bituminous coal	7
		161 pg/J heat input	MC, bituminous coal	7
		10.5 pg/J heat input	Scrubber, bituminous coal	7
	Cyclone	1.4 pg/J heat input	Scrubber, bituminous coal	7
	Stoker	33.0 pg/J heat input	MC, bituminous coal	7
	Pulverized	36.1 pg/J heat input	ESP, anthracite coal	7
	Stoker	0.01 pg/J heat input	MC, anthracite coal	7
	Pulverized dry bottom	36.1 pg/J heat input	MC, lignite coal	7
		5.7 pg/J heat input	Scrubber, lignite coal	7
		18.1 pg/J heat input	Uncontrolled, lignite coal	7
	Pulverized wet bottom	14.2 pg/J heat input	MC, lignite coal	7
	Cyclone	3.4 pg/J heat input	Scrubber, lignite coal	7
		3.1 pg/J heat input	MC, lignite coal	7
	Stoker	36.1 pg/J heat input	Uncontrolled, lignite coal	7

Pollutant	Process	Emission Factor	Notes	Reference
Selenium (continued)	Utility boilers -			
	Tangential, wall	2.0 pg/J heat input	Scrubber, residual oil	7
		10.1 pg/J heat input	Uncontrolled, residual oil	7
	Industrial boilers -			
	Pulverized	48.6 pg/J heat input	MC, coal-fired	7
		41.0 pg/J heat input	Scrubber, coal-fired	7
	Stoker	36.1 pg/J heat input	MC, coal-fired	7
		84.3 pg/J heat input	Uncontrolled, coal-fired	7
	Tangential, wall	2.0 pg/J heat input	Scrubber, oil-fired	7
		10.1 pg/J heat input	Uncontrolled, oil-fired	7
	Commercial boilers -			
	Stoker	84.3 pg/J	Uncontrolled, coal-fired	7
	Tangential, wall	10.1 pg/J	Uncontrolled, residual or distillate oil	7
	Residential boilers -			
	All	143 pg/J	Uncontrolled, bituminous coal	7
	All	99.3 pg/J	Uncontrolled, anthracite coal	7
	All	51.6 pg/J	Uncontrolled, lignite coal	7
	All	2.9 pg/J	Uncontrolled, distillate oil	7
Toluene	Waste oil combustion	0.37 - 35.9 lb/1000 gal		3
	Benzoic acid production -			
	Process	0.0010 lb/lb produced		3
	Storage	0.0004 lb/lb produced		3
	Fugitive	0.0002 lb/lb produced		3
	Benzaldehyde production -			
	Process	0.0009 lb/lb produced		3
	Storage	0.0004 lb/lb produced		3
	Fugitive	0.0002 lb/lb produced		3
	Coke production	0.48 lb/ton coke		2
Trichloroethylene	Open top vapor degreasing	0.785 kg/kg used		20
	Conveyorized degreasing	0.85 kg/kg used		20

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Vanadium (V)	Industrial sources -			
	Mining and processing	25 lb/ton of V processed	Uncontrolled	8
	Metallurgical processing			
	Ferrovanadium, electric furnaces	50 lb/ton of V processed	Uncontrolled	8
	Handling losses	10 lb/ton of V processed	Uncontrolled	8
	Steel production			
	Blast furnace	0.03 lb/ton of pig iron produced	Uncontrolled	8
	Open-hearth furnace			
	No oxygen lance	0.006 lb/ton of steel produced	Uncontrolled	8
	Oxygen lance	0.01 lb/ton of steel produced	Uncontrolled	8
	Basic oxygen furnace	0.002 lb/ton of steel produced	Two venturi scrubbers	8
		0.009 lb/ton of steel produced	Uncontrolled	8
	Electric furnace	Negligible	Uncontrolled	8
	Cast iron production	0.2 lb/1000 ton of charge	Uncontrolled	8
	Cement plants			
	Dry process (for all processes)	Below detection limit of analytical technique	Uncontrolled	8
	Wet process			
	Kiln (average of two)	0.1 lb/1000 ton of feed	ESP	8
	Clinker cooler	0.0005 lb/1000 ton of feed	Baghouse	8
		0.02 lb/1000 ton of feed	ESP	8
		Below detection limit of analytical technique	Two baghouse collections in parallel	8
	Finishing mill after air separator	0.0002 lb/1000 ton of feed	Baghouse	8
	Coal combustion	0.0003 - 0.004 lb/ton	10 - 20 ppm V content; ESP (lower end of factor range). Wet scrubber (upper end of factor range).	8
	Oil combustion -			
	U.S. crude oils	0.0007 - 0.6 lb/1000 gal	0.1 - 78 ppm V content; uncontrolled	8
	U.S. residual, average	0.2 lb/1000 gal	30 ppm V content; uncontrolled	8

Pollutant	Process	Emission Factor	Notes	Reference
Vanadium (V) (continued)	Oil combustion -			
	Foreign crude oils, average	0.8 - 3 lb/1000 gal	116 - 336 ppm V content; uncontrolled	8
	Foreign residual oils, average	0.4 - 2 lb/1000 gal	50 - 280 ppm V content; uncontrolled	8
	U.S. boilers -			
	Distillate units	0.00007 lb/1000 gal		8
	#6 Residual units	0.3 lb/1000 gal	223 ppm V content; uncontrolled	8
	#5 Residual units	0.09 lb/1000 gal	88 ppm V content; uncontrolled	8
	#4 Residual units	0.2 lb/1000 gal	86 ppm V content; uncontrolled	8
	Solid waste incineration	0.001 lb/ton of waste burned	Uncontrolled	8
	Coal combustion - utility boilers -			
	Pulverized dry bottom, bituminous coal	39.4 ng/J heat input	ESP	7
		62.8 ng/J heat input	Scrubber	7
		110 ng/J heat input	Uncontrolled	7
	Pulverized wet bottom, bituminous coal	32.3 ng/J heat input	ESP	7
	Cyclone, bituminous coal	30.1 ng/J heat input	ESP	7
		30.0 ng/J heat input	Scrubber	7
	Stoker, bituminous coal	24.9 ng/J heat input	Multicyclones	7
	Pulverized, anthracite coal	59.3 ng/J heat input	ESP	7
	Stoker, anthracite coal	24.9 ng/J heat input	Multicyclones	7
	Pulverized dry bottom, lignite coal	17.5 ng/J heat input	ESP	7
	Pulverized wet bottom, lignite coal	0.01 ng/J heat input	ESP	7
	Cyclone, lignite coal	233 ng/J heat input	ESP	7
		291 ng/J heat input	Multicyclones	7
	Stoker, lignite coal	24.9 ng/J heat input	Multicyclones	7
	Oil combustion - utility boilers -			
	Tangential, residual oil	3.3 ng/J heat input	ESP	7
		1516 ng/J heat input	Uncontrolled	7

SECTION 2 (Cont.)

Pollutant	Process	Emission Factor	Notes	Reference
Vanadium (V) (continued)	Oil combustion - utility boilers -			
	Wall, residual oil	3.3 pg/J heat input	ESP	7
		1516 pg/J heat input	Uncontrolled	7
	Coal combustion - industrial boilers -			
	Pulverized, coal	33.0 pg/J heat input	Multicyclones	7
		24.0 pg/J heat input	Scrubber	7
	Stoker, coal	24.9 pg/J heat input	Multicyclones	7
		58.1 pg/J heat input	Uncontrolled	7
	Oil combustion - industrial boilers -			
	Tangential	260 pg/J heat input	Scrubber	7
		1000 pg/J heat input	Uncontrolled	7
	Wall	260 pg/J heat input	Scrubber	7
		1000 pg/J heat input	Uncontrolled	7
	Coal combustion - commercial boilers -			
	Stoker, coal	51.8 pg/J heat input	Uncontrolled	7
	Oil combustion - commercial boilers -			
	Tangential, residual oil	3660 pg/J heat input	Uncontrolled	7
	Wall, residual oil	3660 pg/J heat input	Uncontrolled	7
	Tangential, distillate oil	30.0 pg/J heat input	Uncontrolled	7
	Wall, distillate oil	30.0 pg/J heat input	Uncontrolled	7
	Coal combustion - residential boilers -			
	All furnaces, bituminous coal	71.8 pg/J heat input	Uncontrolled	7
	All furnaces, anthracite coal	56.2 pg/J heat input	Uncontrolled	7
	All furnaces, lignite coal	34.4 pg/J heat input	Uncontrolled	7
	Oil combustion - residential boilers -			
	All furnaces, distillate oil	10.1 pg/J heat input	Uncontrolled	7

Pollutant	Process	Emission Factor	Notes	Reference
Vinylidene chloride	Vinylidene chloride production -			
	Reactor vent	6.2 kg/Mg produced	Uncontrolled	24
		0.12 kg/Mg produced	Incinerator	24
	Distillation vents	0.7 kg/Mg produced	Uncontrolled	24
		0.070 kg/Mg produced	Controlled	24
	Storage/handling	0.056 kg/Mg produced	Controlled	24
	Fugitives	0.96 kg/hr	Uncontrolled	24
		0.12 - 0.76 kg/hr	Controlled	24
	Perchloroethylene/trichloroethylene production -			
	Chlorination:			
	Neutralization vent	2.5 kg/Mg produced	Uncontrolled	24
		0.5 kg/Mg produced	Refrigerated condenser	24
	Distillation vent	0.106 kg/Mg produced	Uncontrolled	24
		0.021 kg/Mg produced	Refrigerated condenser	24
	Oxychlorination:			
	Reactor vent	3.8 kg/Mg produced	Uncontrolled	24
		0.076 kg/Mg produced	Thermal oxidation	24
	Drying column vent	0.4 kg/Mg produced	Uncontrolled	24
		0.008 kg/Mg produced	Thermal oxidation	24
	Distillation vent	0.098 kg/Mg produced	Uncontrolled	24
		0.020 kg/Mg produced	Scrubber	24
	Vinylidene chloride polymerization -			
	Reactor	3.5 kg/Mg polymerized		24
	Monomer recovery	0.33 kg/Mg polymerized		24
	Unloading/storage	2.1 kg/Mg polymerized		24
	Fugitive	2.8 - 11 kg/Mg polymerized		24
	High-vinylidene chloride copolymer fabrication processes -			
	Cellophane coating	10 - 120 g/Mg		24
	Latex coating	50 - 1500 g/Mg		24
	Extrusion	2 - 25 g/Mg		24

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